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# Command and control in the Systems Technology Battle Lab

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## Monterey, California



# THESIS

**COMMAND AND CONTROL IN THE SYSTEMS TECHNOLOGY BATTLE LAB**

by

Michelle L. Glenn

June 1999

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Gary Porter

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**13. ABSTRACT** ***(maximum 200 words)*** Joint Vision 2010 introduces the emerging operational concepts of Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-Dimensional Protection enabled by Information Superiority. Information Superiority is gained through operational architectures that closely couple the capabilities of sensors, C2, and "shooters." This architecture of future warfare can be characterized as "Network Centric Warfare." The Navy's response to adapt and develop new operational concepts in support of Network Centric Warfare is Information Technology for the Twenty First Century (IT-21). IT-21 is a reprioritization of existing Command, Control, Communications, Computers, and Intelligence (C4I) programs of record focused on accelerating the transition to a personal computer (PC)-based tactical and support warfighting network. Battle Labs exist Service-wide to aid in this growth process. Battle labs are focused organizations created to explore new technology, concepts, doctrine, or tactics, techniques and procedures to improve the efficiency and combat power of the forces. The Systems Technology Battle Lab was established to inject an academic viewpoint into experiments and research sponsored by the MBC and Commander, Third Fleet (COMTHIRDFLT). Currently, the documentation on the systems installed and how they work together to provide a centralized forum for experimentation and research is inadequate. The purpose of this thesis is to provide the STBL user with a guide describing the capabilities of the STBL and an example of its utilization in an integrated form.

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# COMMAND AND CONTROL IN THE SYSTEMS TECHNOLOGY BATTLE LAB

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requirements for the degree of

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**ABSTRACT**

Joint Vision 2010 introduces the emerging operational concepts of Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-Dimensional Protection enabled by Information Superiority. Information Superiority is gained through operational architectures that closely couple the capabilities of sensors, C2, and "shooters." This architecture of future warfare can be characterized as "Network Centric Warfare." The Navy's response to adapt and develop new operational concepts in support of Network Centric Warfare is Information Technology for the Twenty First Century (IT-21). IT-21 is a reprioritization of existing Command, Control, Communications, Computers, and Intelligence (C4I) programs of record focused on accelerating the transition to a personal computer (PC)-based tactical and support warfighting network. Battle Labs exist Service-wide to aid in this growth process. Battle labs are focused organizations created to explore new technology, concepts, doctrine, or tactics, techniques and procedures to improve the efficiency and combat power of the forces. The Systems Technology Battle Lab was established to inject an academic viewpoint into experiments and research sponsored by the MBC and Commander, Third Fleet (COMTHIRDFLT). Currently, the documentation on the systems installed and how they work together to provide a centralized forum for experimentation and research is inadequate. The purpose of this thesis is to provide the STBL user with a guide describing the capabilities of the STBL and an example of its utilization in an integrated form.

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## EXECUTIVE SUMMARY

Joint Vision 2010 introduces the emerging operational concepts of Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-Dimensional Protection enabled by Information Superiority. Information Superiority is gained through operational architectures that closely couple the capabilities of sensors, command and control (C2), and "shooters." This architecture of future warfare can be characterized as "Network Centric Warfare." The Navy's response to adapt and develop new operational concepts in support of Network Centric Warfare is Information Technology for the Twenty First Century (IT-21). IT-21 is a reprioritization of existing Command, Control, Communications, Computers, and Intelligence (C4I) programs of record focused on accelerating the transition to a personal computer (PC)-based tactical and support warfighting network. Battle Labs exist Service-wide to aid in this growth process. Battle labs are focused organizations created to explore new technology, concepts, doctrine, or tactics, techniques and procedures to improve the efficiency and combat power of the forces. The Naval Postgraduate School Systems Technology Battle Lab (STBL) has been a member of the Federated Battle Laboratory since May 1998. It has been updated to model the Sea-Based Battle Lab (SBBL) on the USS Coronado and the Maritime Battle Center's (MBC) lab in Newport, Rhode Island. The purpose of the upgrade is to inject an academic viewpoint into experiments and research sponsored by the MBC and Commander, Third Fleet (COMTHIRDFLT). Currently, the documentation on the systems installed and how they work together to provide a centralized forum for

experimentation and research is inadequate. The purpose of this thesis is to provide the STBL user with a guide describing the capabilities of the STBL and an example of its utilization in an integrated form.

This thesis defines the C2 process as it exists in the STBL. The C2 process involves gaining situational awareness, planning courses of action, comparing or rehearsing the courses of action, course of action selection and implementation, and course of action assessment. The process is supported by the following STBL capabilities: Operational Planning/Distributed Collaborative Planning, Modeling and Simulation, Battlespace Management, and Intelligence Analysis.

In addition, this thesis discusses the C2 applications resident in the STBL and provides a quick-reference matrix integrating the C2 process with the C2 systems. These systems include:

- Common Operational Modeling, Planning and Simulation Strategy (COMPASS),
- Command and Control Personal Computer (C2PC),
- Enhanced Linked Virtual Information System II (ELVIS II),
- Generic Area Limitation Environment (GALE-LITE),
- Global Command and Control System (GCCS),
- GroupSystems,
- Land Attack Warfare System (LAWS),
- MAGTF Tactical Warfare Simulator (MTWS),

- Naval Simulation System (NSS), and
- Microsoft NetMeeting.

This thesis incorporates a fictional scenario to illustrate the integration of the C2 Process and Systems that enable the IT-21 concept. The concept is applied to a simulated, non-permissive, non-combatant evacuation operation executed at the Joint Task Force level. This scenario can be simulated in the STBL or the other existing battle labs.

# I. INTRODUCTION

This thesis examines the Command and Control (C2) structure within the Systems Technology Battle Lab (STBL) and the applications within the lab that support the structure. Background information relevant to the mission of the lab is presented in this chapter.

## A. BACKGROUND

The vision for future Joint warfighting is described in Joint Vision 2010 (JV2010). JV2010 introduces the emerging operational concepts of Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-Dimensional Protection enabled by Information Superiority. Figure 1 illustrates the pillars of JV2010.

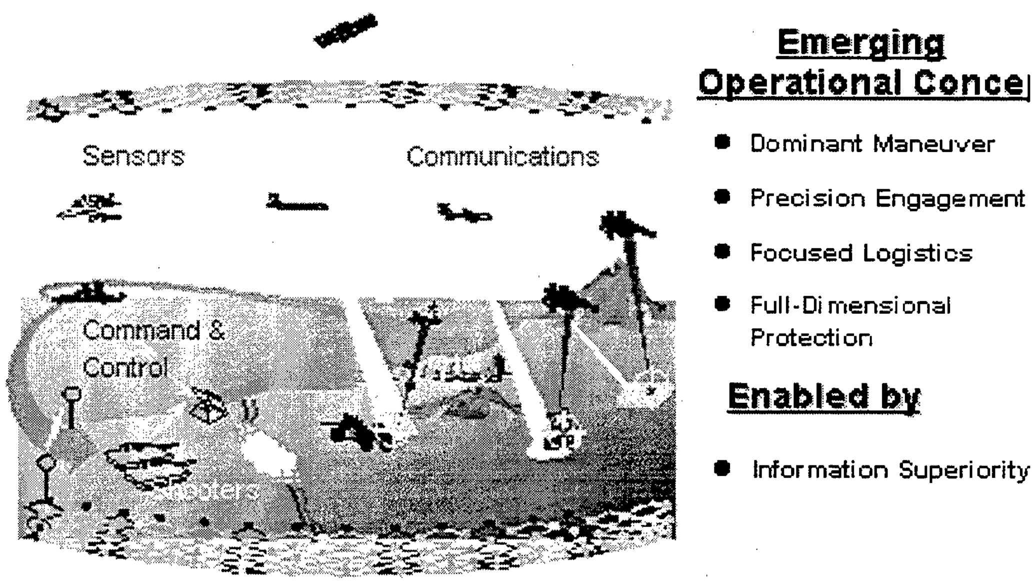


Figure 1. Pillars of JV2010 [Ref. 1]

Information Superiority is gained through operational architectures that closely couple the capabilities of sensors, C2, and "shooters." The primary mechanism for generating increased combat power by 2010 will be the comprehensive networking of sensors, command and control, and "shooters." This can be characterized as "network centric" and the vision of future warfare described in JV2010 can be characterized as "Network Centric Warfare." [Ref.1] The Navy's response to adapt and develop new operational concepts in support of Network Centric Warfare is Information Technology for the Twenty First Century (IT-21). IT-21 is a concept, an umbrella term for the consolidation of existing programs and innovative applications. In addition, several battle labs have emerged to test the new operational concepts to include the Maritime Battle Center (MBC), the Sea-Based Battle Lab (SBBL), and the Systems Technology Battle Lab (STBL) at the Naval Postgraduate School (NPS).

### 1. Network Centric Warfare

The concept of Network Centric Warfare, as opposed to "platform centric warfare," is a derivative of network computing made largely possible by recent developments in information technology. The onset and growth of networking and Internet technologies such as transmission control protocol/internet protocol (TCP/IP), hypertext transfer protocol (HTTP), hypertext markup language (HTML), Web browsers, and Java computing have led the ongoing "revolution in military affairs." These developments make it easier for computers with different operating systems to interact with each other. The relationships between the operational concepts of JV2010, Information Superiority, and Network Centric Warfare is represented by operational architectures that effectively link sensors, C2, and shooters to increase Joint combat power. [Ref. 1] The "Grid", illustrated in Figure 2 highlights the network centric information flow between sensors, C2, and shooters and suggests three sub- architectures: an information grid, a sensor grid, and a shooter grid.

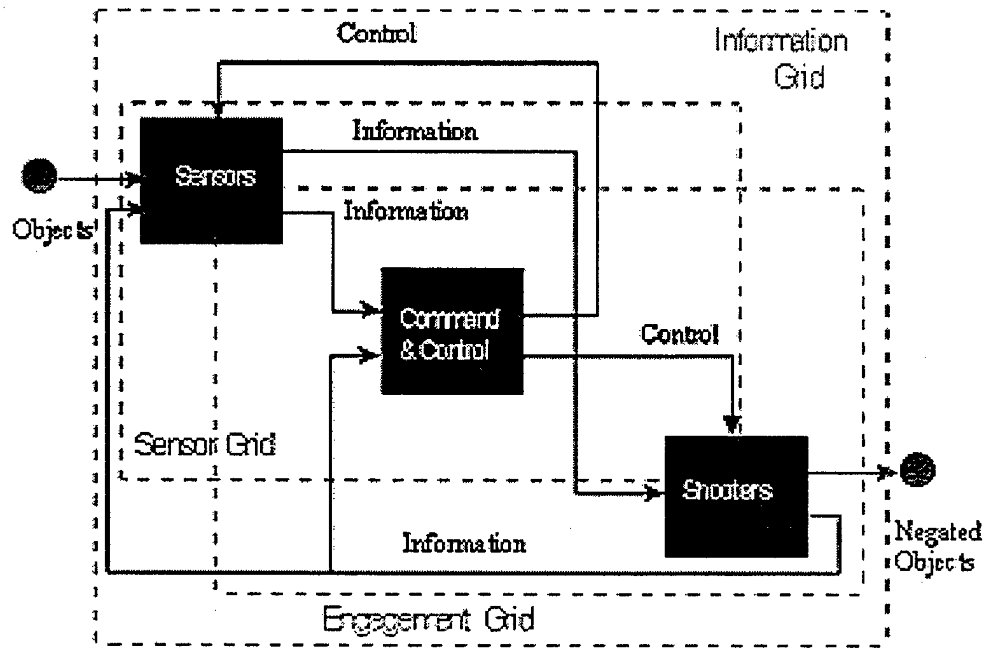


Figure 2. The "Grid" [Ref. 1]

### *a. Information Grid*

The information grid consists of both military and commercial communication capabilities and cognitive information processing nodes. It transmits multiple information types in multiple modes at multiple data rates. Voice, data, and video can be transmitted via point-to-point or direct broadcast. The information grid provides the means to receive, process, transport, store and protect information for Joint and combined forces. This grid provides the necessary infrastructure to permit the "plug and play" of sensors and shooters. [Ref. 1]

#### *b. Sensor Grid*

The sensor grid is composed of air, sea, ground, space, and cyberspace based sensors tied together in a virtual network. The sensor grid provides the force with a high degree of awareness of friendly forces, enemy forces and the environment across the battlespace. [Ref. 1]

#### *c. Shooter Grid*

The shooter grid provides the warfighter with new operational capabilities for force employment including predictive planning and preemption, integrated force management, and execution of time-critical missions. The shooter grid peripherals consist of shooters based in the air, land, sea and cyberspace. [Ref. 1]

The concept of Network Centric Warfare provides an organizing principle for JV2010. The operational architectures of the information grid, sensor grid, and shooter grid provide a structure for how individual components of existing and future warfighting forces are integrated to enable the network centric operational concept of Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-Dimensional Protection. Figure 3 highlights these principles. [Ref. 1]

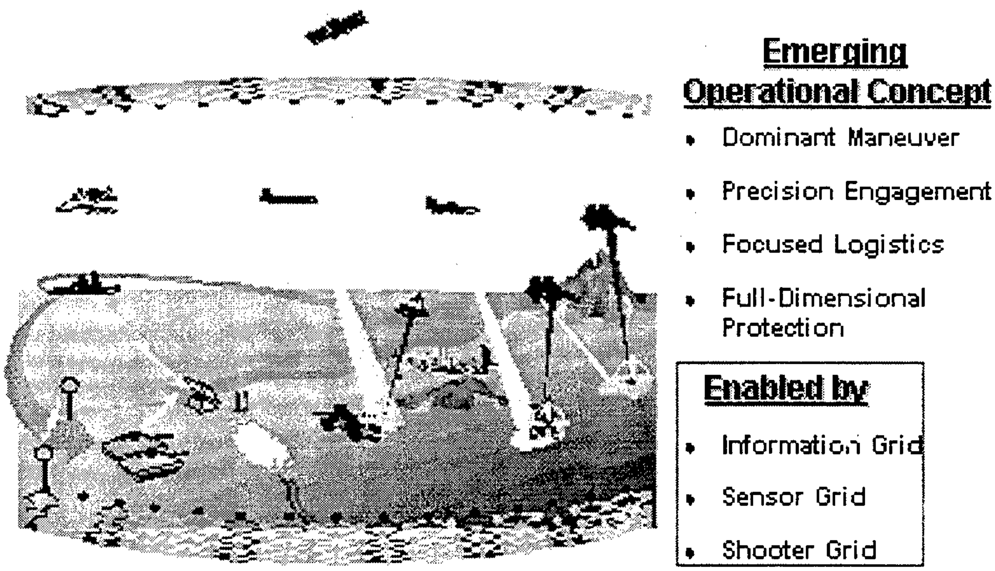


Figure 3. Pillars of JV2010 and Network Centric Warfare [Ref.1]

### 2. IT-21

IT-21 is a reprioritization of existing Command, Control, Communications, Computers, and Intelligence (C4I) programs of record focused on accelerating the transition to a personal computer (PC)-based tactical and support warfighting network. The goal of IT-21 is to link U.S. forces (and eventually coalition forces) together in a Commercial-Off-The-Shelf (COTS) and Government-Off-The-Shelf (GOTS) network environment that enables voice, data and video transmissions from a single desktop PC. This allows warfighters to exchange classified and unclassified, tactical and non-tactical information from a single desktop computer, shorten timelines, and increase combat power. [Ref. 2] IT-21 represents a philosophical C4I warfighting process transformation:

- Away from expensive, single-function work stations to affordable, highly capable personal computers.

- Extensive use of web technology to manage data to produce knowledge.
- Seamless ashore/afloat transfer of voice, video, and data information.
- TCP/IP-based, client-server environment with multi-level security.
- Embracing industry standards, open architectures and COTS.
- Merging of tactical and non-tactical data on a common infrastructure.

The principal elements of IT-21 are Asynchronous Transfer Mode (ATM) local area networks (LANs) afloat and LANS/wide area networks (WANs) ashore populated by state-of-the shelf PCs. These networks integrate tactical and tactical support applications with connections to enhanced satellite systems and ashore networks. It will be supported by regional network operating centers and all elements will be Defense Information Infrastructure (DII) Common Operating Environment (COE) compliant. [Ref. 3]

### 3. Battle Labs

The rapidly increasing pace of change brought on by doctrinal changes and technology advancements has prompted the Services to create organizations that revolutionize the front end of the developmental process. Battle labs are focused organizations created to rapidly identify and examine innovative ideas to improve the ability of U.S. forces to execute their core competencies in support of JV2010. Battle labs explore areas involving new technology, concepts, doctrine, or tactics, techniques and procedures to improve the efficiency and combat power of the forces. They explore and measure the potential of evaluated initiatives using courses of action ranging from modeling and simulation to actual employment of forces in exercise environments. At the completion of the assessment, battle labs often provide specific recommendations to senior leadership. [Ref. 4]

In June 1997, the Federated Battle Lab (FBL) was established. The FBL is a consortium of the Joint Battle Center and Service Battle Labs formed to promote near term C4I solutions to Joint Task Force (JTF) operational problems and explore new C4I capabilities in a collaborative experimental environment. The FBL focuses on the assessment of useful, functionally interoperable Joint C4I capability improvement initiatives for the CINCs, Services, and other government agencies. The FBL provides the forum and infrastructure in which the Joint warfighter can interactively engage in capability and utility assessments with FBL components during evaluations of proposed hardware and software C4I improvements with a goal of rapid insertion for the warfighter. [Ref. 5] By combining the assets of each FBL facility, a comprehensive assessment of initiatives covering the spectrum of new operational concepts, processes and procedures can also be accomplished with recommendations for Joint warfighter doctrine; tactics, techniques and procedures; and organizational modifications. The FBL forms a bridge to JV2010's goal of focusing the aggregate strengths of the Services on operational concepts that improve JTF readiness, Information Superiority, and Full Spectrum Dominance. The Navy currently has three member battle labs: the Maritime Battle Center in Newport, Rhode Island; the Sea-Based Battle Lab aboard the USS Coronado; and the Systems Technology Battle Lab in Monterey, CA. [Ref. 5]

## B. PURPOSE

The Systems Technology Battle Lab has been a member of the Federated Battle Laboratory since May 1998. It has been updated to model the Sea-Based Battle Lab on the USS Coronado and the Maritime Battle Center's lab in Newport, Rhode Island. The purpose of the upgrade is to inject an academic viewpoint into experiments and research sponsored by the MBC and Commander, Third Fleet (COMTHIRDFLT). Currently, the documentation on the systems installed and how they work together to provide a centralized forum for experimentation and research is inadequate. The purpose of this thesis is to provide the STBL user with a guide describing the capabilities of the STBL and an example of its utilization in an integrated form.

## C. SCOPE

The scope of this thesis is primarily oriented toward potential users of the STBL to include students, faculty, and staff of the Naval Postgraduate School. Therefore, the objective of this thesis is to describe the command and control process as it applies to the STBL and the systems resident in the STBL that support this process, as well as provide an example of how these systems can work together. The C2 process definitions will be described at the sub-Joint Task Force (JTF) level and C2 system descriptions will be represented at the basic overview level. Systems not resident in the STBL will be excluded from this thesis.

## D. THESIS ORGANIZATION

Chapter I has provided a basic overview of the concepts and visions that are the background for this thesis. These concepts include Joint Vision 2010, Network Centric Warfare, and the Navy's IT-21. Chapter II will define the C2 process as it exists in the STBL. The C2 process involves gaining situational awareness, planning courses of action, comparing or rehearsing the courses of action, course of action selection and implementation, and course of action assessment. The process is supported by the following STBL capabilities: Operational Planning/Distributed Collaborative Planning, Modeling and Simulation, Battlespace Management, and Intelligence Analysis. Chapter III will furnish the overviews of the C2 applications resident in the STBL. It will also provide a matrix integrating the C2 process with the C2 systems to summarize Chapters II and III. Chapter IV will be an example of one way a user could utilize some of the applications in planning and executing experiments and research in the STBL. Chapter V will conclude the thesis with a summary.

## II. STBL C2 PROCESS

This chapter will begin by briefly introducing the C2 process and the STBL capabilities that support this process. This will be followed by a description of the four C2 capabilities in the STBL to include: Operational Planning/DCP, Modeling and Simulation, Battlespace Management, and Intelligence Analysis. The chapter will summarize with a generic representation of how the capabilities of the STBL could be utilized in an exercise or experiment. Command and Control is defined as:

> The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures, which are employed by a commander in planning, directing, coordinating and controlling forces and operations in the accomplishment of the mission. [Ref. 6]

The concept of command and control (C2) and several variations of this concept are a common part of today's military vocabulary. Though their definitions may seem apparent, these terms are defined differently depending upon the user's perspective. Frank Snyder's definition as stated in Command and Control: The Literature and Commentaries is the most useful for the purposes of this chapter. Snyder sections the DOD definition into three concepts. First the C2 function is "The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission." Second, the C2 process are "procedures which are employed by a commander in planning, directing, coordinating and controlling forces and operations in the accomplishment of the mission." Finally, C2 systems are "an arrangement of personnel, equipment, communications, facilities." [Ref. 6] It is important to distinguish between the C2 process and C2 systems. [Ref. 6]

One definition of the C2 process is illustrated in the Lawson-Moose Model of the C2 process. Figure 4 diagrams this process in five steps. [Ref. 7]

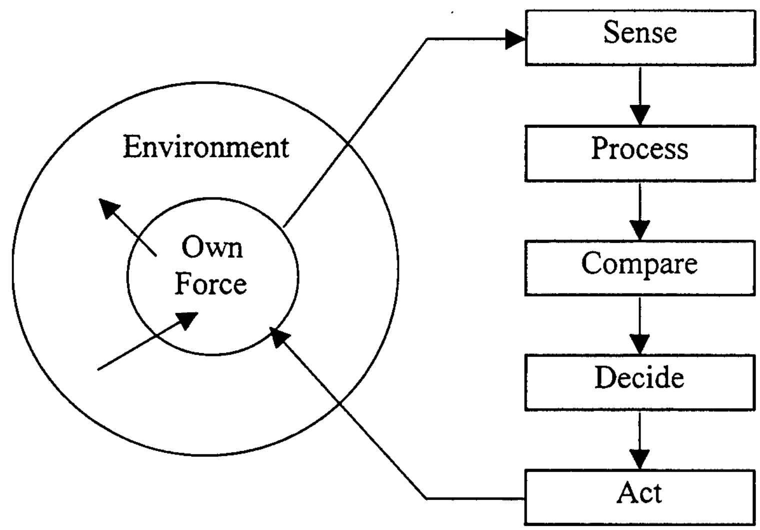


Figure 4. Lawson-Moose Model [Ref. 7]

The C2 process steps are sensing the environment, processing the sensed information, comparing present state to the desired state, deciding upon the course of action to take (often using a decision aide), and then acting upon that decision. Commanders when presented with a crisis situation or tasking from upper echelons will:

- Assess the situation or tasking
- Plan and develop courses of action
- Compare or rehearse these courses of action

- Select and implement a course of action
- Assess the performance of that course of action

[Ref. 7] More often than not, the selection and implementation of a course of action will have a cascading effect, forcing subordinate commanders to initiate their own C2 loop. Figure 5 illustrates this concept.

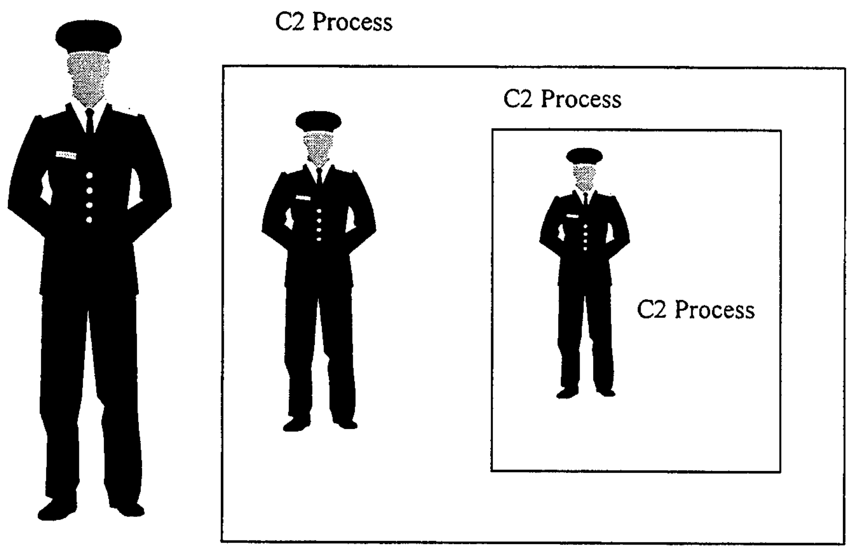


Figure 5. Commander and the C2 cycle. The C2 cycle often has a cascading effect.

The applications and tools in the STBL can be segregated into four categories that work together or individually: Operational Planning/Distributed Collaborative Planning (DCP), Modeling and Simulation, Battlespace Management, and Intelligence Analysis. Assessing a situation requires obtaining information about the situation or environment, such as the positions and status of friendly and enemy forces, the terrain, and background information on enemy strategies and cultures. This information is often supplied using intelligence products and Battlespace Management tools. Courses of action (COAs) are then developed using Operational Planning/DCP tools. The COAs can be loaded into Modeling and Simulation applications to analyze and compare the COAs and determine tradeoffs and benefits. A course of action is selected and implemented. Course of action evaluations and corrections can be done through Battlespace Management tools.

To explain the C2 process, Thomas Coakley uses the analogy of a head coach of a football team and compares it to the commander. [Ref. 8] Figure 6 illustrates how the STBL "categories" interact and relate to Coakley's analogy: "Football is not combat, and a one hundred-yard playing field is a far cry from the global battlefield, but the parallels between the activities of a coach and the activities of commanders can help us better understand C2."

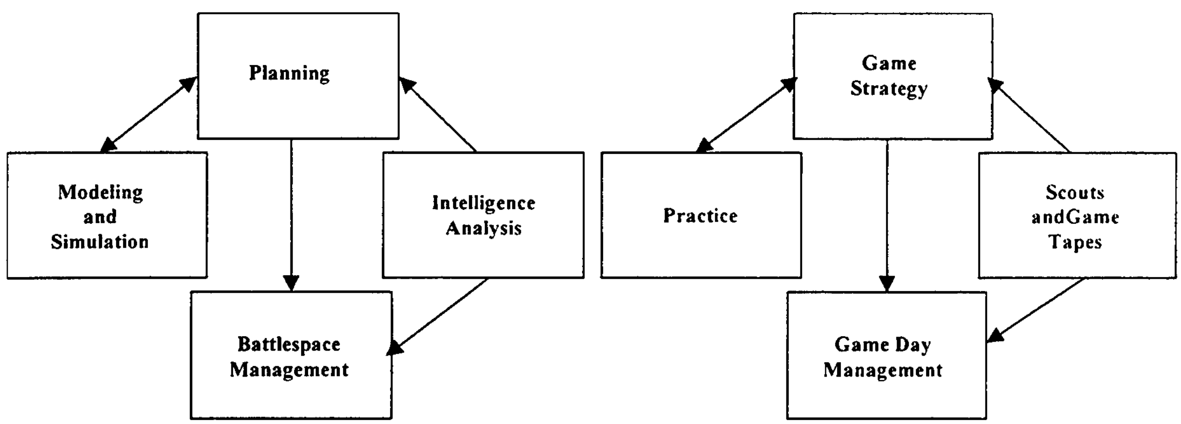


Figure 6. Football Analogy Diagram

The head coach, the "commander", is the primary decision-maker for the organization. Before an important game, the head coach must decide on a game plan based upon the contents of the team's playbook and information obtained about the opposing team's capabilities, strengths, and weaknesses. Before executing a mission task, the commander must select courses of action from plans developed using Operational Planning strategies and information about the enemy. Both the coach and the commander must rely on scouts and subordinates (Intelligence Analysis tools in the case of the commander) to correlate opposition information into a useful product. After selecting appropriate plays, the coach runs team practices to rehearse those plays and receive feedback on their simulated success. The coach also uses practice to assess the status of team readiness and provide training when needed. The commander utilizes Modeling and Simulation tools to rehearse operational plans and examine new doctrine. In addition, many of the tools are used to assess unit readiness and train troops in a pre-deployment environment. On game day, the head coach watches the progress of the game on the football field constantly evaluating the progress, receiving feedback and directing adjustments, as necessary to achieve the first down, kick a field goal, or pursue the touchdown. The commander assesses mission progress from Battlespace Management applications that provide him with the Common Operational Picture (COP) and makes adjustments based upon feedback and new information. [Ref. 8]

In summary, a user in the STBL steps through four stages: Operational Planning/DCP to develop a game strategy with appropriate game experts; Modeling and Simulation to rehearse it; Battlespace Management to follow the game, receive feedback, and make adjustments as necessary; and Intelligence Analysis to provide initial situational awareness for planning and feedback for adjustments. The next section will define each of these capabilities. The summary will give a generic model of how some of these components can be used together in the prosecution of an exercise or experiment in the STBL. Chapter IV will provide a more detailed example.

## A. OPERATIONAL PLANNING

Operational Planning is defined as:

> A coordinated joint staff procedure used by a commander to determine the best method of accomplishing assigned tasks and to direct the action necessary to accomplish the mission. [Ref. 9]

The planning process is cyclic and continuous. In simplistic terms, it begins when a task is assigned and proceeds until a complete plan is documented and delivered. In response to a task assignment, the commander first determines a "commander's intent" of envisioned operations to center the planning process and proceeds to gather information relating to the status and plans of opposition forces. Courses of Action are developed based upon the resources available to the commander, status of own forces, and information gathered on the opposition and the environment. Detailed plans are developed from the most appropriate course of action. The commander reviews the detailed plans, approves them, and implements them. [Ref. 9] The planning processes can be described in broad terms:

- Receive and analyze the task to be accomplished
- Review the enemy situation and begin to develop the necessary awareness of enemy forces (intelligence), own forces (readiness and availability), and the environment (weather, geography, terrain)

- Develop and compare alternative courses of action
- Select the best alternative
- Develop and get approval for its concept
- Prepare a plan, and
- Document the plan [Ref. 9]

### 1. Distributed Collaborative Planning

Various theater Commanders-in-Chiefs (CINC) have a stated warfighting requirement to conduct Distributed Collaborative Planning (DCP) supported by modeling and simulation. DCP is defined as enabling many operational users to simultaneously participate in the mission planning process ("collaborative") without the need to be co-located ("distributed"). In the past, plans were most often developed by co-located personnel assigned to the Plans Department. With the increase in joint and coalition operations, planning personnel and subject matter experts are more often than not geographically dispersed. Collaborative systems allow a group of users to work simultaneously and interactively on a common task. An example is video teleconferencing. Distributed Collaborative Planning (DCP) is the military implementation of collaborative systems. DCP is a concept utilized by the military to coordinate planning conducted by geographically dispersed C2 elements. DCP methods use communications and computing systems to permit close interaction among C2 elements to increase military responsiveness and efficiency. [Ref. 10] The aim of DCP is to improve the quality of operational plans, while reducing the time and effort required for developing, coordinating, and approving plans for execution. DCP is distributed because it is a process conducted among dispersed planning activities. The operation-planning environment is a decentralized array of command centers, functional expertise, data resources, and planning systems. Using DCP, planning systems, information resources and planning products are shared among a networked planning and execution cooperative. DCP is collaborative because planners can communicate in depth in real-time using video teleconferencing, simultaneous document and image sharing, and group-level access to a shared application. The collaborative environment is a virtual meeting place where many different experts assemble to plan. [Ref. 10]

DCP applications are composed of one or more of the following elements:

- Electronic Mail (e-mail) is the most common form of collaboration.
- File Transfer Protocol (FTP) supports a wide range of information exchange and distribution tasks. File transfers are used to distribute bulk information such as intelligence reports, imagery, maps, reference material, briefings and databases
- Shared Document Systems permit concurrent viewing, editing, and annotating documents among two or more contributors
- Shared Mapping Tools extend the shared document concept to mapping products including overhead imagery. Shared Mapping tools are used to convey intelligence information, weather conditions, and location-related data

- Shared Applications Tools permit one or more network members to share access to a computer program that actually resides somewhere else on the network
- Desktop and Real-Time Data conferencing permits communication equivalent to telephone interactions in the form of audio transmissions, text-based chat sessions, and PC-based video
- Electronic Meeting Systems permit military planners to assemble virtually and conduct distributed meetings as required. [Ref. 11]

STBL applications that support this capability include COMPASS, ELVIS II, GroupSystems, and NetMeeting.

## B. MODELING AND SIMULATION

Operations research was developed in WWII in response to the military needs of WWII. Operations research is a scientific method. It is an organized activity with a more or less definite methodology of tackling new problems and finding solutions. Military staffs and combat analysts exploited several of its methods to develop better tactics and operations. It is also an applied science utilizing scientific techniques as tools in solving a particular problem. "Military systems analysis is an extension of operations research techniques of WWII to problems of broader context and longer range—e.g., force composition and development as well as operations decisions." [Ref. 12] Combat analysis, as an extension of operations research, often uses mathematics and logic to study the phenomena at hand. Certain aspects of practically every operation can be measured and compared quantitatively with similar aspects of other operations. Performance and effectiveness measurements provide a quantitative means of determining the extent mission requirements are being met, the degree a system is affecting the environment in which it is operating, or the impact an operational decision has on combat outcomes.

Wayne Hughes, in Military Modeling, stated, "A model is a simplified representation of the entity it imitates or simulates." [Ref. 13] The purpose of modeling is to remove superfluous details and complexities of reality and expose essential variables, constants, and relationships to draw conclusions, make predictions, or support the decision making process. Military modeling provides a solid basis to improve performance, quality, and timeliness of decisions made. [Ref. 14] Models can be categorized by technique or level of abstraction and include analytical representations, computer simulations, war gaming, and field experiments. [Ref. 13] Analytical representations are mathematical formulas processed through computers. Computer simulations imitate physical phenomena such as firepower and troop movement. Decision-making is represented by pre-programmed engagement rules and may be defined probabilistically. War games, on the other hand, include one or more human players often referred to as human-in-the-loop. Field experiments are "real life" simulations of combat scenarios involving "real-life" personnel and equipment. [Ref. 13] STBL applications that fall under this category include MAGTF Tactical Warfare Simulator and Naval Simulation System.

## C. BATTLESPACE MANAGEMENT

The commander is faced with making tough decisions in an operational environment of uncertainty and limited time. Snyder emphasizes that the goal of the C2 process (and a key criterion used to select supporting systems) is to reduce uncertainty and time in the prosecution of mission taskings. [Ref. 6] New technologies have increased by orders of magnitude the amount of information available to the commander. The focus of today's commander is as much on information management as it is on executing difficult and complex warfighting tasks. Consequently, much of the C2 effort is directed toward the objective of facilitating intelligent decision-making by managing and presenting information in a product format appropriate to the commander. The utilization of a COP helps to reduce uncertainty and supports a common thread that extends information from the foxhole to the Commander-in-Chief.

The COP concept is generally depicted as a scaleable presentation of timely, fused, accurate, and relevant information tailored to meet users needs at all echelons. The Joint Chiefs of Staff, Publication 6-0 states,

> The Warrior needs a fused, real-time, true picture of the battlespace and the ability to order, respond and coordinate vertically and horizontally to the degree necessary to prosecute the mission in that battlespace. [Ref. 15]

The purpose is to achieve battlespace awareness including information on the disposition and intent of hostile forces; total asset awareness of own forces; visibility of allied/neutral forces; terrain and weather; and the status of the information environment. Information is presented as a single, accurate, and interactive common picture disseminated on an as needed basis [Ref. 16]. The Global Command and Control System (GCCS) and the Command and Control Personal Computer (C2PC) provide the fused picture for the STBL. In addition, the Land Attack Warfare System (LAWS) provides commanders with a counter-fire COP (CF COP) ensuring that the commander receives all the available information in a timely manner, and can filter it to his mission, geography, and echelon.

## D. INTELLIGENCE ANALYSIS

Intelligence provides information and insights that are unique, reducing the uncertainty of decision-making at all echelons. Intelligence analysts take information gained from various collection resources and combine it with information from publicly available resources to produce an "all source" analysis for their customers. Typically the intelligence process begins when tasking requests are injected into the intelligence architecture to direct and prioritize collection requirements. Raw data gathered from collection resources are converted and correlated into a form usable as combat information or intelligence. The products are disseminated directly to the users or stored in databases available to users on an as needed basis. [Ref. 17] The Generic Area Limitation Environment-lite (GALE-LITE) supports this capability in the STBL and is an example of a fused-data product. An example of using raw intelligence data is monitoring a real-time video feed from the Unmanned Aerial Vehicle Predator over the Global Broadcast System (see Appendix for more information).

## E. SUMMARY

The capabilities described in the STBL can be used together to develop and implement exercises and experiments and to support operations. When given a scenario, users in the STBL can

- develop courses of action with geographically separated material experts utilizing planning and DCP applications,
- model the courses of action on modeling applications,
- inject the resulting analysis into the planning process and compare the performance of the available courses of action,
- select a course of action, and develop a detailed plan,
- model the detailed plan, and use the results to make adjustments as necessary,
- simulate the scenario, and simulate the implementation of the plan using Battlespace Management tools.

In addition, an experiment to measure the situational awareness of the disparate nodes of participants throughout this process can be easily accommodated.

This chapter discussed the four capabilities supporting the C2 process as it exists in the STBL. These capabilities are Operational Planning/DCP to prepare for contingencies, Modeling and Simulation to rehearse plans, Battlespace Management to maintain and adjust the tactical picture, and Intelligence Analysis to inject appropriate information in the process. Chapter III will follow with descriptions of the C2 systems that support these capabilities. Chapter IV will use a fictional scenario to illustrate the integration of the C2 process and C2 systems.

# III. STBL C2 SYSTEMS

The previous chapter outlined each of the modules in the STBL C2 process: Operational Planning/DCP, Modeling and Simulation, Battlespace Management, and Intelligence Analysis. Systems that support the C2 process can be referred to as command and control (C2) systems; command, control, and communications (C3) systems; command, control, communications, and computer (C4) systems; command, control, communications, computers, and intelligence (C4I) systems; and more. Although many variations exist, all share a common purpose. The function of any C2 system is to support the C2 process. This chapter will describe (in alphabetical order) the C2 applications that support the capabilities discussed in Chapter II.

## A. COMMON OPERATIONAL MODELING, PLANNING AND SIMULATION STRATEGY (COMPASS)

Using COMPASS services, military planners at all echelons have the capability to link various C4I and mission planning systems together on a common wide area network to share data, conduct collaborative planning, and collaboratively consult remote battle labs or modeling and simulation expertise at various locations around the world. [Ref. 18]

COMPASS provides a non-intrusive middleware approach that facilitates DCP processes in the combined arms planning environment. COMPASS allows planners using disparate C4I, mission planning, and modeling and simulation systems to move between local planning, collaborative planning, plan analysis, and simulation-based rehearsal modes. COMPASS capabilities include a client-server architecture with GOTS DCP services (session management, shared overlays, composite route preview, and defense interactive simulation or COP track management), COTS DCP services (audio, video, whiteboard, and chat), and the ability to initiate collaboration with -- and observe -- external modeling and simulation products on host C4I and mission planning systems. [Ref. 18]

COMPASS capabilities can be employed at all echelons of a Combined or Joint Task Force (CTF/JTF) structure, including at mobile and fixed locations. It can function in operational settings ranging from office and lab facilities to field and shipboard environments. The COMPASS operational environment is limited only by the inherent restrictions of the host system's applications and hardware, and by the stability of local area network (LAN)/wide area network (WAN) connectivity. There are no additional power requirements and workstation footprints remain the same on the host system computers. Connections to Transmission Control Protocol/Internet Protocol (TCP/IP) routed networks are required (security classification remains the same as the highest classification of the participating host system's). [Ref. 18]

#### 1. System Description

The COMPASS strategy uses five basic COMPASS services to link Joint and Service C4I planning and modeling and simulation systems across diverse warfare areas to form a distributed collaborative planning and mission rehearsal architecture. COMPASS client-server applications include:

#### *a. Session Management (SMGT)*

The COMPASS architecture provides the capability to establish and maintain a distributed planning and rehearsal session involving one or more session participants. Planners can join, monitor, leave, and rejoin a DCP session at will. There are no inherent restrictions on the number of participants (13 station participant sessions have been demonstrated) and all users can share identification data (i.e., local name, planning role, etc.) with other session participants. [Ref. 18]

#### *b. Shared Overlay Management (SOM)*

The Shared Overlay Manager of COMPASS allows session participants to create geo-registered planning overlays depicting mission specific data. Geo-registered overlays are automatically scaled to the recipient's selected application scale factor. This feature permits the planner to assess the impact of a planned mission on all other mission participants, as well as analyzing the mission's threat exposure. Weapons effects, biological and chemical dispersion patterns, nuclear fallout assessments, or other information may be displayed to the mission planner using the Shared Mission Overlay. Users can create, save, delete, and exchange map overlays. They can use a variety of graphical symbols (e.g., shapes, keyboard entries, freehand text, and drawings) to create or annotate these displays. The planned mission will be constructed and/or edited and placed into the SOM. From the SOM, all session participants can download it for geo-registered viewing on their particular host system. The overlay will be a "read only" type of file and will not be subject to editing. [Ref. 18]

#### *c. Composite Route Preview (CRP)*

COMPASS provides for animation and correct position/orientation of graphical icons as they execute designated navigation routes. CRP can be seen on all participating DCP systems and is synchronized in time and space. The planner is given an opportunity to view the entire mission, identifying potential route and timing conflicts before they happen. Planners may preview in real time or control the speed for other than real time simulations. The background display (e.g., terrain) retains the characteristics of the host system viewing the mission preview. [Ref. 18]

#### *d. Distributed Interactive Simulation (DIS) Mission Rehearsal*

Modeling and simulation systems output simulation data in DIS Protocol Data Units (PDU). COMPASS provides the capability to receive and process DIS PDUs for mission rehearsal displays. All DCP session participants can view a collaborative plan as it is being executed by a local and/or remote DIS-based modeling and simulation system. Some of these simulations consist of cockpit and platform views and are displayed in a scaleable window on the host system. The simulation can run in real time or a multiplier of it. [Ref. 18]

#### *e. Track Data Base Management Server (Track Server)*

Using the same functionality as DIS-based mission rehearsal, selected tracks from the Global Command and Control System (GCCS) Track Data Base Manager can be shared and updated with all other COMPASS-capable workstations. These tracks can also be shared with non-GCCS COMPASS workstations despite their limitations in accessing the COP directly or their compliance level within the DII COE. The track server provides all participants within a COMPASS session the ability to receive automatically updated tracks from the COP at pre-selected update rates. The client pulls this data based upon its optimal update rate requirement. COMPASS enabled GCCS is still in the DISA approval process. [Ref. 18]

The following services are COTS applications allowing planner-to-planner communication and information exchange:

#### *f. Whiteboard (WB)*

The shared whiteboard (Rendezvous) is an application that permits session participants to exchange text and graphics. Relevant information can be "cut and pasted" from C4I, mission planning and modeling and simulation systems into the whiteboard for discussions during collaborative sessions. In addition, WB tools permit drawing, typing, and image sharing. The Rendezvous WB currently used in conjunction with COMPASS has a client-server architecture and other features such as an integrated (but separate) chat capability.

### g. *Visual Audio Teleconferencing (VAT)*

COMPASS includes the ability to teleconference among DCP players using COTS video/audio teleconferencing applications installed on C4I, mission planning, and modeling and simulation systems. VAT is a tool that mission planners can employ to conduct face-to-face discussions during collaborative planning sessions.

### h. *Chat*

This capability is provided through the Rendezvous Whiteboard (attached chat capability outside the WB environment). Chat is a versatile capability that allows text-to-text exchange of typed information during periods of low or degraded bandwidth availability. Because of this factor, it is typically both the primary and default means of collaborating. [Ref. 18]

COMPASS has been installed in nearly 22 different host applications. The following host systems are indicative of capabilities that exist today.

### i. *Area Air Defense Commander's Planner (AADC-P)*

The AADC-P is a system defined by its collection of capabilities, current and projected, that allow the warfighter to utilize the " best and the most robust" functionalities of various communications networks, planning, C4I and modeling and simulation applications. Information for AADC-P is accessed through three separate network connections: Joint Planning Network (JPN), Joint Composite Tracking Network (JCTN), and Joint Data Network (JDN).

These network connections allow AADC-P to draw information from both the GCCS and TDS/JDN architectures. In addition, AADC-P has architectural segments that allow it to operate in planning, execution and coordination roles. This architecture provides AADC-P with a variety of information sources and permits it to move seamlessly from one network to another. [Ref. 18]

#### *j. Tactical Aircraft Mission Planning System 6.1 (TAMPS)*

TAMPS is an automated, Navy/Marine Corps aviation mission planning system. It is an interactive, graphics-aided computer system with extensive databases and the processing capability to construct, analyze, store, and download mission data for strike aircraft and stand-off weapon systems. TAMPS uses Mission Planning software, various types of data, and Arc Digital Raster Graphics (ADRG) provided by the National Imagery Mapping Agency (NIMA) to assist users in all facets of modern aircraft mission planning. [Ref. 18]

#### *k. Air Force Mission Support System C2.0 (AFMSS)*

AFMSS is similar to TAMPS in functionality and program structure. It is a combat and non-combat aircraft mission planning system which provides two generic products derived as a result of that planning process: air crew products and aircraft data. The air crew products include a Combat Mission Folder with information such as maps, images, routes, etc. Aircraft data is stored in a mission data transport cartridge called a data transfer device (DTD), which is uploaded prior to each launch. The

Aircraft/Weapon/Electronics (A/W/E) software modules embedded in AFMSS are unique to Air Force specific aircraft and requirements. [Ref. 18]

#### *l. Global Command and Control System 3.0 (GCCS)*

See GCCS system description below.

#### *m. Maneuver Control System 12.01 (MCS)*

MCS is designed to serve as the Army's primary C4I system for Division level and below and is planned for eventual integration with Army's GCCS (AGCCS). It can initiate Operational Orders, transfer those orders to other MCS users, import enemy and friendly Orders of Battle through the Army's ASAS Warrior notebook interface, and plan ground operations from Corps to Brigade levels. [Ref. 18]

#### *n. Contingency Theater Automated Planning System 5.2 (CTAPS)*

CTAPS provides the means to rapidly develop and receive Air Tasking Orders (ATO) and Airspace Control Orders (ACO) that can be shared through COMPASS overlays with other host planning/C4I systems. COMPASS-capable CTAPS can access and share information from various CTAPS modules which produce Air Tasking Order (ATO) message format files or an Airspace Control Order (ACO) root file. CTAPS distributes the ATO/ACO to other COMPASS sites, using various COMPASS capabilities -- including geo-referenced shared overlays to display the ACO on non-CTAPS systems -- or to modeling and simulation centers for plan analysis and assessment. [Ref. 18]

### *o. PowerScene 4.3.0*

PowerScene is a commercial, scaleable software application that uses digital imagery to generate dynamic perspective scenes of actual terrain (cockpit view) for a variety of military applications. These include data fusion from intelligence sources, mission review, planning, training, situational awareness, and image generation for synthetic environments used for systems development. The system runs dynamic 3-D display scenes in real time. PowerScene uses terrain imagery and data in standard (NIMA) formats directly, as well as data from numerous other sources, to create large area databases. The system seamlessly renders dynamic terrain views within these theater-sized, geographical databases in real time. PowerScene is a virtual and DIS simulation provider. [Ref. 18]

### *p. Extended Air Defense Simulation 6.00c (EADSIM)*

EADSIM is a powerful analytical tool for evaluating the effectiveness of various systems and C4I architectures. The model provides a simulation environment that permits an analyst to evaluate system performance and command and control and engagement processes for selected platforms in a variety of battle scenarios, which include Theater Missile Defense (TMD) and Air Defense. EADSIM provides a many-on-many theater-level simulation of air and missile warfare, an integrated analysis tool to support Joint and Combined Force operations, and a tool to augment maneuver force exercises at all echelons with realistic air defense training. It models fixed and rotary wing aircraft, tactical ballistic missiles, cruise missiles, infrared and radar sensors, satellites, command and control structures, sensor and communications jammers, communications networks and devices, and fire support in a dynamic environment which includes the effects of terrain and attrition on the outcome of the battle. [Ref. 18]

#### *q. Coordinated Adaptive Planning System 2.0 (CAPS)*

CAPS, a theater-level planning tool, is an unclassified version of the NATO Nuclear Planning System. Major CAPS software components include force allocation, graphical user interface, conventional modeling / planning, plan validation, interactive route planning (IRP), and fallout assessment (FAS).

#### *r. Hazard Prediction and Assessment Capability 3.0 (HPAC)*

HPAC is a general hazard modeling capability for modeling Nuclear, Biological, and Chemical (NBC) effects as a result of terrorist or hostile forces against U.S. and Allied forces. Additionally, it can be used for modeling U.S. and Allied strikes against NBC weapons, storage or manufacturing facilities, or hostile force weapons systems engaged by U.S. and Allied defensive systems (such as a NBC equipped ballistic missile engaged by U.S. and Allied surface-to-air missiles). HPAC also provides a workstation-based capability for winds over complex terrain and for forecasting weather, which is required for accurate hazard assessment in some locations and situations. [Ref. 18]

#### *s. Nuclear, Chemical, Biological and Radiological Planner (NCBR/P)*

NCBR/P predicts downwind hazard patterns when provided with a source/threat, location, time, and meteorological data (auto or manual input). It is capable of calculating ATP-45 warning fans for weapons of mass destruction (WMD), downwind hazard patterns, and intensity level contour plots. These overlays are color-coded and contain embedded hazard level data. Additionally, through COMPASS SOM services, NCBR/P can share geo-referenced prediction/calculation weapons effects overlays with any other COMPASS-capable workstation. [Ref. 18]

### 2. Technical Description

Each of the COMPASS services is provided in such a way as to ensure that DCP session participants can operate the DCP service on their planning, modeling, or simulation workstation without degradation of the native application. Additionally, integration of COMPASS services with the C4I, planning, modeling, or simulation systems will not alter the host system's basic characteristics.

COMPASS can reside on host C4I, mission planning, and modeling and simulation systems hardware, including the Sun SPARC and Ultra family of computers, HP Desk Top Computers (DTC) 2, 3, and 4, Silicon Graphic Incorporated computers, and PCs operating with Windows NT. If the host workstation does not include a video board, microphone, speaker, and video camera, they may be added (to all except some DTCs) to take advantage of COMPASS audio and video capabilities. [Ref. 18]

The core COMPASS architecture uses client-server architecture for the purposes of DCP session management, shared overlay management, composite route preview, and DIS-based mission rehearsal. All COMPASS-capable systems are built to function as both a server and a client, which enhance no-notice or short-notice planning, while providing redundancy and a graceful degradation capability in combat. If a system running servers is rendered inoperative, any other system in that planning session can take the role of server and resume DCP within minutes.

C4I, planning, and modeling and simulation systems host and interface with COMPASS Client Library Computer Software Configuration Items (CSCI) which enable the exchange of mission planning information among collaborating systems through the medium of COMPASS Server CSCI. COMPASS Client Library and COMPASS Server CSCI enable collaboration in the areas of (1) shared map overlay planning, (2) composite route preview, and (3) DIS-based mission rehearsal. Planning session management services are also provided. In the GCCS application, in addition to core COMPASS functionality, Collaborative Virtual Workspace (CVW) is used to execute the COMPASS functionality's within a virtual planning room. Figure 7 depicts the major components of the COMPASS software architecture. [Ref. 18]

COMPASS Servers and COMPASS Client Libraries will implement all inter-processor communications (IPC) services and collaborative functions required to exchange data elements. These data elements comprise a "transfer syntax" that enables the efficient exchange of C4I, planning, and modeling and simulation information using minimum communication bandwidth.

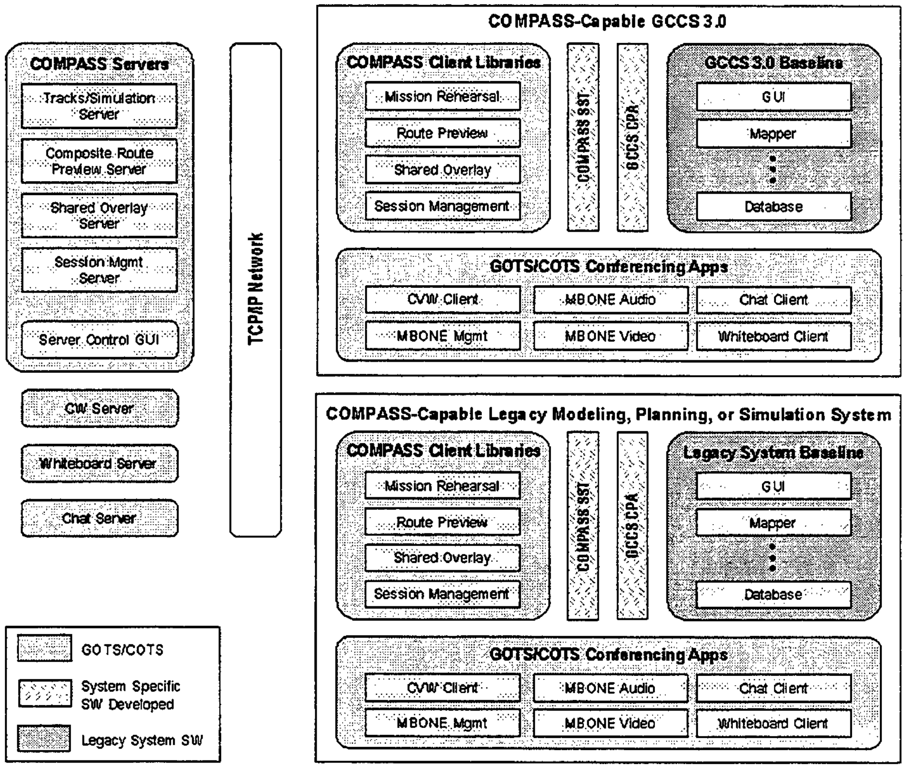


Figure 7. COMPASS Software Architecture [Ref. 18]

The COMPASS System Specific Interfaces (SSIs) are unique to each legacy modeling, planning, or simulation system. The SSI acts as a presentation layer between the COMPASS Client Library and the legacy system, localizing all translation between COMPASS "transfer syntax" and local "implementation syntax." COMPASS SSI development and maintenance is the responsibility of the COMPASS-capable host system's program office. [Ref. 18]

The COMPASS Collaborative Planning Applications (CPAs) are the means by which DCP is accomplished. The COMPASS CPAs are unique to each C4I, planning, and modeling and simulation systems. The CPA provides a user interface and tools for collaborative planning, isolates collaborative (public) planning from local (private) planning, and makes maximum use of the host system's native graphical user interface (GUI), mapping, and database components. COMPASS CPA development and maintenance is the responsibility of the COMPASS-capable system's host program manager. [Ref. 18]

Because COMPASS is based on a non-intrusive middleware concept, as shown in Figure 8, it can be inserted rapidly and relatively inexpensively into existing C4I, mission planning or modeling and simulation systems without impacting on the native, or host, application's capabilities or manner of operating. Additionally, COMPASS capabilities can be designed concurrent with development of new or emerging systems with minimal impact on original design features or capabilities. [Ref. 18]

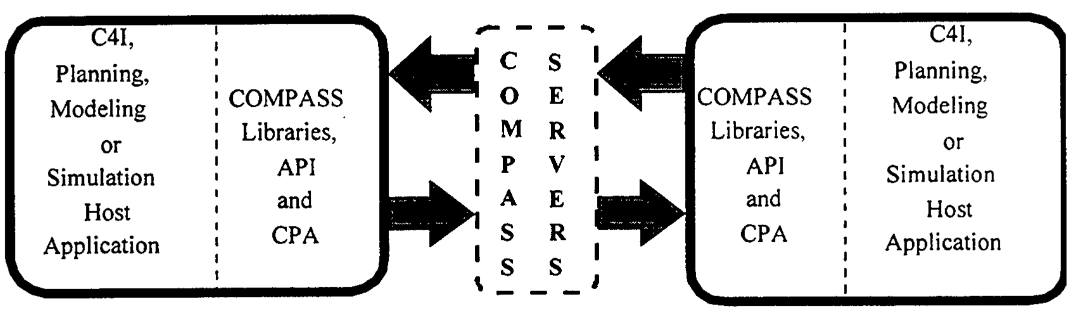


Figure 8. COMPASS Physical Architecture [Ref. 18]

## B. COMMAND AND CONTROL PERSONAL COMPUTER (C2PC)

Command and Control PC is a client application that displays the most recent COP update from the GCCS database. The purpose of the C2PC application is to provide a C4I client capability for a range of Windows 95/NT application areas.

### 1. System Description

There are three components which muake up C2PC: a Host Machine, C2PC Client, and C2PC Gateway. A limited system description is provided here due to classification. Additional information can be found at http://www.mctssa.usmc.smil.mil /systems/c2pc/c2pcweb. The technical description has been omitted due to classification.

#### *a. Host Machine*

The Host Machine is the central source that feeds information to the Gateway and Client. A Host machine is required for C2PC to receive automatic updates to track information. It also provides the overlays that can be imported into C2PC.

#### *b. C2PC Client*

The Client is the C2PC component that displays the map window and C2PC menu structure. Each C2PC workstation must contain a Client to run C2PC.

#### *c. C2PC Gateway*

The Gateway is the C2PC component that processes track information received from and sent to the Host. The Gatreway must be up and running for the Client to receive track updates. The workings of the Gateway are transparent to the user.

## C. ENHANCED LINKED VIRTUAL INFORMATION SYSTEM (ELVIS)

Recent technological advances in computer software and protocols have been the catalysts for an unprecedented level of system connectivity and information exchange. Web applications are now available that provide access to geographic plots and tabular displays of tactical information from remote GCCS hosts using only a browser with TCP/IP connectivity. ELVIS has emerged as the prototypical example with capabilities including high-resolution maps, COP view, tactical overlays, and ATOs. The tactical commander can remotely view situational displays maintained by different sites, access tactical databases, and evaluate data consistency between cooperating sites. The traditional C4I "push" of data between systems is augmented in several ways including on-demand internet browser "pull" of data, event-by-event webcasting/"invited push" of data, or a push/pull custom blend which can be implemented using a variety of web tools (e.g., browser scripting languages and Java). [Ref. 19]

### 1. System Description

ELVIS I was designed to provide a platform-independent web browser interface to GCCS with sufficient user functionality to support C4I core services including:

- Selection of map products (with zoom, re-center, etc.)
- Control over tactical plotting and filtering (for units and overlays)
- Interrogation of tactical objects via point-and-click and ad hoc search
- Access to ATOs and ACOs
- Display of LINK 11 (complete with pairing lines to ATO missions)

- Access to status-of-forces data (readiness, schedules, etc.)

In many settings, a web interface provides the most efficient means to access information from an easy to use browser interface. ELVIS I follows the browser paradigm and facilitates navigation through the information domain by tightly integrating tactical and status-of-forces data. Access control is provided by the challenge/response protocol between web browser and web server, with authentication based on a database of user accounts. ELVIS I is based on standard HTML (no Java) and is completely server-based. Specifically, ELVIS I consists of various Unix-based processes that cooperate with GCCS core services to create HTML documents. The only application running on the client is the web browser. There is no "ELVIS I" client; no additional software is loaded on the client. [Ref. 19]

The most prominent criticism of ELVIS I stemmed from the lack of dynamic, event-by-event positional updates. ELVIS II solves this problem using Java. Java offers a true client/server environment with all of the advantages of HTML for remote access and hardware independence. ELVIS II reuses two of the key server components of ELVIS I, the GCCS track database module and GCCS geographic chart module. However, unlike ELVIS I, the plotting of all tactical data (tracks, overlays, ATOs, etc.) is performed by the ELVIS II client Java applet. This is the basis of the ELVIS II client/server architecture. The GCCS server (coordinated by the ELVIS II server) performs map creation and track correlation. The client plots and declutters. User queries are serviced at either the client or server, depending on the type of query. A track's latest positional data is maintained at the client to permit rapid filtering, plotting, and query. Track histories are maintained at the server (to minimize the client's memory footprint and to reduce bandwidth loading). [Ref. 19]

Each ELVIS II client maintains a TCP/IP connection to the ELVIS II server. This allows the ELVIS II server to coordinate and synchronize client operations, thereby enabling a collaborative planning mode. Although the COP is designed to synchronize tactical databases among cooperating sites, there is no provision in the COP to impose or enforce a common display representation. Two sites may have identical databases, but individual users can view different geographic areas with different plot controls (e.g., air picture vice surface picture). The ELVIS II architecture has been carefully designed to support "shared" display controls. The ELVIS II server accepts display/plotting instructions from a "master controller" ELVIS II client and forwards them to all "slave" ELVIS II clients participating in the collaborative session. These instructions are comprehensive across the full range of all map operations, track filtering and plotting, and object activation (for overlays, track groups, PIMs, ATOs, etc.), thereby creating a single shared tactical "canvas" on which users can draw using a set of scribble tools. [Ref. 19]

All users have complete freedom of action to annotate and draw on the shared canvas, but only the master controller can modify the canvas' geographic and tactical reference frame (i.e., the map, plot controls, object activation, etc.). The scribble tools respect geographical references so that map changes maintain the latitude/longitude positions of scribble objects. Furthermore, the state of a collaborative session is preserved so that late joiners to a session inherit the current canvas configuration including all active scribble objects. [Ref. 19]

### 2. Technical Description

ELVIS II utilizes a form of communication known as the client-server paradigm. A server application waits passively for contact, while a client application initiates communication actively. Information can pass in either or both directions between a client and a server. Typically, a client sends requests to a server, and the server returns responses to the client. In the case of ELVIS II, the server provides continuous output without any request—as soon as the client contacts the server, the server begins sending data (e.g., the ELVIS II server sends continuous COP updates). A client and server use a transport protocol to communicate. ELVIS II utilizes TCP/IP. As Figure 9 shows, a ELVIS II interacts directly with a transportation layer protocol to establish communication and to send or receive information over the Secret Internet Protocol Router Network (SIPRNET), the secret layer of the Defense Information Systems Network (DISN). [Ref. 20]

## D. GENERIC AREA LIMITATION ENVIRONMENT (GALE-LITE)

GALE-LITE is a software package that provides intelligence analysts with tools to access and exploit target information. The data used by GALE-LITE is provided by real-time data feeds or is retrieved from historical contact data files. Information describing the capabilities of GALE-LITE are classified SECRET and can be found in the GALE-LITE User's Manual in the STBL.

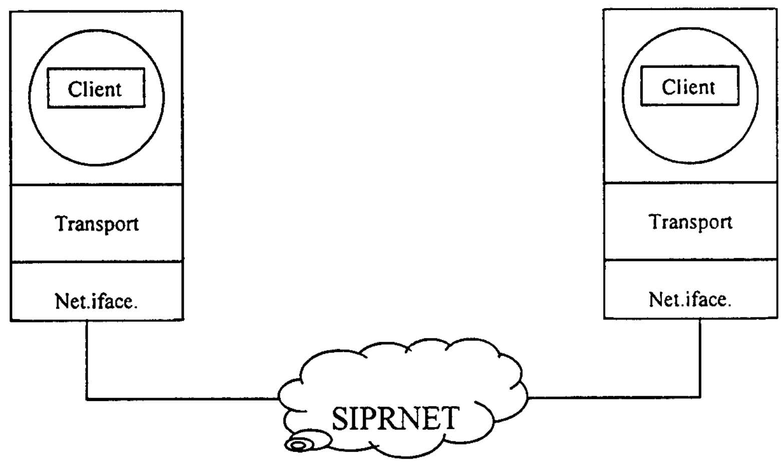


Figure 9. Client-Server over TCP/IP [Ref. 20]

## E. GLOBAL COMMAND AND CONTROL SYSTEM (GCCS)

> The Warrior needs a fused, real-time, true picture of the battlespace and the ability to order, respond and coordinate vertically and horizontally to the degree necessary to prosecute the mission in that battlespace. [Ref. 15]

The Command, Control, Computers, Communications and Intelligence for the Warrior (C4IFTW) concept dictates a requirement for the capability to move a U.S. fighting force throughout globe at anytime, and to provide it with the information and direction to complete its mission. The Global Command and Control System is the mid-term implementation of this requirement. GCCS is an automated information system designed to support deliberate and crisis planning with the use of an integrated set of analytic tools and flexible data transfer capabilities. Modular by design, its applications can be shifted among common terminals regardless of the Service owner. When combined with the transmission capabilities of the Defense Information System Network, GCCS provides a global wide area network capability with a fused picture of the battlespace within modern C4I systems.

### 1. Systems Description

GCCS software applications are categorized into two groups: Common Operating Environment (COE), and Mission applications. [Ref. 21]

The Defense Information Infrastructure (DII) Common Operating Environment (COE) provides a standard environment, "off-the-shelf" software, and a set of programming standards that describe in detail how mission applications will operate in the environment. The COE contains common support applications and platform services required by mission applications. [Ref. 21]

The use of standard data elements is key to any automated system's success. Using standard data eliminates redundancies and provides a common base to facilitate information exchange, reducing time needed to set up a basis for data communication. GCCS is composed of several mission applications built into a single common operating environment networked to support sharing, displaying, and passing of information and databases. Mission applications include:

#### *a. Joint Operation Planning and Execution System (JOPES)*

The Joint Operation Planning and Execution System (JOPES) is the integrated command and control system used to plan joint military operations. It is a combination of joint policies, procedures, personnel, training and a reporting structure supported by automated data processing on GCCS. The capabilities of the JOPES mission applications support translation of the National Command Authority's policy decisions into planning and execution of joint military operations. JOPES is an entire system for conducting joint contingency planning in both the deliberate and crisis response modes. In deliberate planning, JOPES helps in the plan development phase to build the force list and calculate cargo and personnel required to sustain that force. The product of this process is the TPFDD, a transportation-feasible database containing all the forces, materiel, and personnel required to execute and support the CINC's concept of operations. JOPES assists in the development of crisis action plans often partially developed from existing OPLANs. [Ref. 9]

#### *b. Global Reconnaissance Information System (GRIS)*

GRIS supports the planning and scheduling of monthly sensitive reconnaissance operations (SRO) theater requests. The Joint Staff staffs these requests through the office of the Secretary of Defense, Central Intelligence Agency, and State Department for National Security Council approval. Incoming RECON 1/2/3/4 formatted messages are received by an automated message handling system, validated, and passed to the GRIS application for automated processing and database update. GRIS generates all RECON messages and also monitors the monthly execution of theater reconnaissance missions approved in the previous month. The Joint Staff and theater commands exercising operational control (OPCON) over airborne reconnaissance assets use GRIS. [Ref. 21]

### *c. Evacuation System (EVAC)*

EVAC collects and displays information about U.S. citizens located outside the United States as collected by U.S. State Department embassies and consulates. It accesses the database server via TELNET operation from a GCCS compatible client.

### *d. Fuel Resources Analysis System (FRAS)*

FRAS provides fuel planners with an automated capability for determining supportability of a deliberate or crisis action plan and for generating the time-phased bulk petroleum, oil and lubricants required to support an OPLAN. FRAS facilitates review of the fuel requirements of a proposed, new, or revised OPLAN and assesses adequacy of available resources to support crisis action planning. Requirements can be generated and analysis performed for the overall OPLAN, regions within the OPLAN, by Service and within Service by regions. [Ref. 21]

### *e. Global Status of Resources and Training (GSORTS)*

GSORTS provides information on status of units with respect to personnel, equipment and training. Query and display capabilities include categories of units (ships, fighter aircraft, ground forces, etc.); specific types of units (frigates, armor battalions, F-15's, etc.); and by specific unit (displays detailed status information). [Ref. 21]

#### *f. Joint Maritime Command Information System (JMCIS)*

JMCIS is the foundation for the GCCS fused operational battlespace picture. It provides near real-time sea and air tracks. JMCIS receives inputs from different systems, and can interface with other systems. JMCIS uses a core service, known as unified build, to provide geographic display, contact correlation, and track data base management. [Ref. 21]

#### *g. Theater Analysis and Replanning Graphical Execution Toolkit (TARGET)*

TARGET contains a set of planning tools designed to support the operational planner during crisis action procedures. These tools allow planners and operators to accomplish tasks through rapid access to required documents, information sources, analysis tools, multi-media and teleconferencing tools. [Ref. 21]

#### *h. Joint Deployable Intelligence Support System (JDISS)*

JDISS applications provide the intelligence window to access national, theater, and tactical intelligence sources through the joint architecture for intelligence. It provides connectivity and interoperability with intelligence systems required to support forces during peacetime, crisis, and war. JDISS includes INTELINK at the Secret classification level (INTELINK-S). It is an intelligence dissemination service that enhances the sharing of intelligence information electronically over the SIPRNET. INTELINK provides intelligence dissemination using networked information discovery, retrieval, and browsing services. Its "point and click" technology makes intelligence products widely available to both users and producers of intelligence. [Ref. 21]

#### i. *Air Tasking Order (ATO)*

ATO provides the capability to view and print selected portions of air tasking orders. A query function allows the user to tailor requests for information contained in a specified order for viewing. The query function also supports display of color-coded ground tracks for selected portions of the order. ATO interfaces with the Contingency Theater Automated Planning System (CTAPS). [Ref. 21]

### 2. Technical Description

The GCCS infrastructure consists of a client server environment incorporating UNIX-based servers and client terminals as well as personal computer (PC) X-terminal workstations; operating on a standardized local area network (LAN). The GCCS infrastructure supports a communications capability providing data transfer facilities among workstations and servers. Connectivity between GCCS sites is provided by the SIPRNET. Remote user access is also supported via dial-in communications servers, or via telnet from remote SIPRNET nodes. [Ref. 21]

The baseline GCCS architecture consists of a suite of relational database and application servers. At most GCCS sites, the relational database server acts as a typical file server by hosting user accounts, user specific data, and site specific files not part of GCCS. The application servers host the automated message handling system, applications not loaded on the database server and other databases. At each GCCS site, one application server is configured as the executive manager (EM) providing LAN desktop services. It also hosts applications not loaded on the database server. The EM server acts as the user interface providing access to GCCS applications through user identification and discrete passwords. [Ref. 21]

## F. GROUPSYSTEMS

GroupSystems is a suite of team-based, decision support software tools that is promoted to shorten the lifecycle of organizational processes. It is used for strategic planning, reengineering, problem solving, and distributed collaborative planning.

The origins of operational electronic meeting software dates back to 1982 and the University of Arizona's (UA) GroupSystems project. UA researchers started developing collaborative software that would make corporate meetings more productive. It wasn't until 1986 that remote electronic meetings were held using PCs connecting directly to each other via modem, allowing participants to be "distributed." The objective of these early meetings was to enable teams to continue collaborative projects away from the meeting room using the same tools and activities available to them in the meeting room. The software supports group decision-making by providing users with a method to collect and organize information, then vote on a plan. People of differing expertise participate through a format similar to a highly organized Internet chat room while a facilitator decides the process for organizing the information that best fits a given situation. In the Navy, the program could be used to develop different courses of action based on the

Commander's guidance and information provided by experts both on and off the ship. [Ref. 22]

### 1. System Description

GroupSystems supports these processes with tools that manage group processes such as brainstorming, information gathering, voting, organizing, prioritizing, and consensus building. The suite consists of the following tools: Standard package, Survey, Alternative Analysis, and Activity Modeler. The Standard package includes five tools that can handle collaboration and decision-making needs. [Ref. 22]

#### *a. Categorizer*

The Categorizer helps generate a list of ideas and supporting comments. Each participant can enter ideas or comment on existing ideas at the same time as other participants. Participants then create categories, or "buckets," for the ideas and "drop" them into the desired category. Categorizer also allows participants to open another category to view its list of ideas, as well as enter ideas in a private window and submit them one by one (as in the Nominal Group brainstorming technique). [Ref. 22]

#### *b. Electronic Brainstorming*

Electronic Brainstorming provides a process in which a question or issue is distributed to participants, who respond with comments. It is used to promote discussion and creative thinking. Participants can share ideas simultaneously and anonymously. The electronic equivalent of sheets of paper are distributed, one per person. After they enter an idea, the discussion sheet is exchanged for another. This sheet may already contain ideas entered by other people. The participant can then comment on the existing responses or begin a new thought. Electronic Brainstorming can sort comments and create a list of keywords containing important words that categorize the comments. It also allows participants to use synonyms for keywords making searches for comments with similar ideas but different wording easier. [Ref. 22]

#### *c. Group Outliner*

Group Outliner allows the group to create and comment on a multi-level list of topics. It allows groups to explore issues and develop action plans using an outline structure. This tool is particularly useful when GroupSystems is used for distributed sessions. Group Outliner will send only a selected branch of the outline at a time or the entire outline to other group members. [Ref. 22]

#### *d. Topic Commenter*

Topic Commenter offers participants the opportunity to comment on a list of topics. This tool is more structured than Electronic Brainstorming but less than Group Outliner is.

#### *e. Vote*

The Vote provides a variety of methods used to assist the group in evaluating the list of ideas to develop a consensus or to reach a decision. Vote can also help determine the degree of group consensus. For example, participants can use Vote periodically following discussions to determine whether the group consensus has changed. Once the group has voted, participants can view the results in both vote spread and graph windows. The vote spread and standard deviation are provided because these measurements are particularly important for determining the level of consensus in the group. Vote also allows the group to design its own custom voting method as well as build and comment on the list of alternatives. [Ref. 22]

#### *f. Survey*

Survey will allow participants to do periodic customer surveys, performance reviews, marketing focus groups, formal management surveys, and informal questionnaires. Survey assists in gathering, tabulating and analyzing information critical to the decision making process. Survey can be used in a virtual "meeting room' or distributed to participants' desktops over a LAN. Other can use the product on diskette or via e-mail.

#### *g. Alternative Analysis*

Alternative Analysis helps groups explore the strengths and weaknesses of strategic plans, select candidates, determine the impact of a plan on stakeholders, and generate and prioritize product requirements. It allows groups to rate a list of alternatives against a list of criteria using a matrix or spreadsheet format. The results of the evaluation can be viewed in a variety of formats, including scatter plots, bar charts, pie charts, vote-spread tables, and text reports. Alternative Analysis will also test "what if" scenarios by adjusting the weighting of each criteria. Typical applications supported by

Alternative Analysis include customer requirements, evaluation of specifications, stakeholder identification process, personnel evaluations, hiring decisions, and product evaluations. Activity Modeler is a team-based modeling tool that allows a team to work directly and simultaneously on a graphical model of operational processes. [Ref. 22]

### 2. Technical Description

GroupSystems utilizes a client server environment incorporating PC-based servers and client terminals, operating on a standardized local area network (LAN) or the Internet. GroupSystems supports a communications capability providing data transfer facilities among workstations and servers. The SIPRNET, the Non-classified Internet Protocol Router Network (NIPRNET), or the Internet provides connectivity between GroupSystem sites for unclassified collaboration. Remote user access is also supported. [Ref. 22]

The recommended configuration for GroupSystems includes Windows NT Server 4.0 (with Service Pack3) network operating system; Windows 95 client operating system; a Pentium-based, 64 megabytes random access memory, one gigabyte hard drive, 32 bit Ethernet network card file server; a Pentium-based, 32 megabytes random access memory workstation with 30 megabytes of free hard disk space; and a 100 Base-T Ethernet LAN. [Ref. 22]

## G. LAND ATTACK WARFARE SYSTEM (LAWS)

The Land Attack Warfare System is a Battlespace Management tool designed to maintain command and control for fire support. Fire support refers to the act of applying firepower by ground, sea and aerial platforms. The commander employs these assets to suppress, neutralize, or destroy opposition targets. The purpose of critical fire tasks include:

- Close Support Fires to support the maneuver and protection of ground forces;
- Suppression of Enemy Air Defense to the maneuver and protection of air assets;
- Fires to Support Information Operations to attack the opposition's C2 elements;
- Counterfire to attack the oppositions ability to conduct fires; and
- Strike to attack a specific opposition force or function.

LAWS utilizes shared databases and tools to support multiple functional areas. It supports horizontal and vertical coordination, planning, and execution. The principal functional areas include Mission and Information Managers, Targeting Databases, Tools, Situation Awareness, and Interfaces. [Ref. 23]

### 1. System Description

LAWS provides for parallel communications of mission and target data, including automatic updates of target location/course/speed, status of engagement assets (time on station, weapons loads, routes), engagement suggestions (engagement assets, weapon to target pairings, and target intercept), and other mission planning information. The information is provided via the LAWS primary functional areas. Each functional area has several sub-functions described here.

### *a. Mission and Information Managers*

LAWS employs several management segments to support mission execution and information flow. These include:

- Fire Mission Management is an integrated display for the coordination and execution status of fire missions. It has three support areas: functional element coordination, mission execution, and mission fired reports.
- Air Interdiction Mission Management is an integrated display for the coordination and execution status of air interdiction missions. The Air Tasking Order (ATO) is processed to find matching target nominations to automatically update with actual versus requested time on target. Mission nominations are digitally exported to Contingency theater Air Planning System (CTAPS).
- Close Air Support (CAS) Mission Management is an integrated display for the coordination and execution status of CAS missions. It provides the seamless flow of targets from fires and targeting cells, officers, sensors, or other functional elements. Missions for CAS consideration are passed electronically to Air Liaison Officers.
- Fire Support Coordination Measures defines and modifies fire support coordination measures (no fire areas, restricted fire lines) and provides a graphic display of current and planned coordination measures. It can receive or transmit measures from field artillery tactical data systems.

- Weapon Inventory Management and Alerting provides summary and detailed displays of the firing unit's munition inventory.
- Air Tasking Order automatically matches missions with the Basic encyclopedia database to determine target type. It has filtering and viewing functions for aircraft type, mission flow, time on target, and target type.
- Kill Box Manager and Deconfliction creates, manages, deconflicts, and tracks battlefield kill boxes.
- Aviation Route Planning creates and maintains aviation routes for deep attack. Route information is automatically passed to other elements and converted into air space control requests for route and air space deconfliction. Route plans are interactive with LAWS suppression of Enemy air Defense planner.
- Airspace Control Request Management and Deconfliction is used to manage air space control requests. Requests can be defined through user input, airspace control order, or from proposed aviation routes. [Ref. 23]

#### *b. Targeting Databases*

LAWS accesses and pulls information from several databases. These include:

- Integrated Database is a tabular and graphic display of national and theater databases. Target nominations and mensuration requests are automatically generated.

- Mensurated Target Database is a tabular and graphic display of mensurated target database with automatic conversion to target nomination requests. [Ref. 23]

#### *c. Tools*

LAWS utilizes several tools to accomplish the fires mission. These tools include:

- Weapon Target Pairing provides pairing of targets to weapons (platform/weapon/munition)
- Automated Airspace Deconfliction provides deconfliction against pre-planned and near-real time airspace events, rapid analysis of alternative pairing options and will display weapon trajectories, firing and impact points, conflicts, and restricted operating zones.
- Terrain Analysis Tools provides integrated graphic terrain analysis: slope and elevation, line of sight, radar terrain masking, and 3D terrain.
- Suppression of Enemy Air Defense (SEAD) Planner provides a tool for rapid generation and modification of air defense plans. It will graphically display route, threat locations, and threat ranges. It provides interactive selection and inclusion of identified or templated targets into a specified plan. [Ref. 23]

#### *d. Situation Awareness*

LAWS accommodates several segments to support an increase in situational awareness required to properly manage the fires battlespace. These include:

- Digital Mapping and Imagery is a scaleable digital display of all major National Imagery and Mapping Agency (NIMA) products.
- Counterfire Common Operational Picture (CF COP) provides near-real time situation awareness of the counterfire battle to theater components. It utilizes tools to support tactical and strategic operations to include identification of "hot spots" and status and reporting using established target aides.
- Tactical Picture provides a common information display with data accumulated from field artillery tactical data systems and radar, Unmanned Aerial Vehicles, Link 16 and 11 feeds, and other COP sources (GCCS, JMCIS, and modeling and simulation resources).
- Battlefield Information Management utilizes an unlimited number of situational graphic overlays from private or public sources. It automatically updates overlays for fire missions, air interdiction mission, and artillery locations. [Ref. 23]

#### *e. Interfaces*

LAWS incorporates user-friendly interfaces to import and export data from several sources. These sources include field artillery tactical data systems, JMCIS, GCCS, Air Defense System Integrator (ADSI), Naval Simulation System (NSS), and office automation and imagery systems. [Ref. 23]

### 2. Technical Description

The LAWS architecture is scaleable from a single workstation to local and wide area networks. It is DII COE compliant and is object-based in design and implementation. It interfaces with fire direction, C2, and simulation systems. LAWS requires a Pentium-based PC running at 200 Megahertz or higher with 64 Megabytes of Random Access Memory, and a Windows NT operating system. [Ref. 23]

## H. MAGTF TACTICAL WARFARE SIMULATOR (MTWS)

The Marine Air Ground Task Force (MAGTF) Tactical Warfare Simulation (MTWS) is a computer-assisted exercise support tool designed to support training of Marine Corps commanders and their staffs. MTWS is a follow-on program to the Tactical Warfare Simulation, Evaluation and Analysis System (TWSEAS). MTWS is able to support Command Post Exercises (CPX), Field Exercises (FEX), or a combination of both in which combat forces, supporting arms, and results of combat are modeled by the system. MTWS can be used to plan tactical operations, and to evaluate the plan under alternative enemy or environmental conditions. MTWS provides a full range of command and control capabilities including force initialization, planning and scheduling of amphibious operations, air operations and operations ashore, integration and analysis of intelligence data, analysis of comparative combat powers, and calculations and recording of combat losses. [Ref. 24]

### 1. System Description

MTWS provides a full spectrum of combat models. The major functional areas are Ground Combat, Air Operations, Fire Support, Ship-to-Shore movement, Combat Service Support, Combat Engineering, and Intelligence. The system provides limited play in Electronic Warfare, Communications, and Nuclear, Biological, and Chemical Warfare.

#### *a. Ground Combat*

The MTWS ground combat model provides for the direction, management, and simulation of close combat activities for other simulated and real exercise units. Ground unit representations include formation, frontage, heading, posture, assigned mission, and assets. Ground movements are affected by such factors as: terrain or road trafficability; weather conditions; equipment mobility characteristics; natural and man-made obstacles and barriers; and fuel availability. Enemy forces can be detected visually, aurally, or by the use of sensors. [Ref. 24]

#### *b. Air Operations*

MTWS models the following types of air missions: air reconnaissance, combat air patrol (CAP), airborne early warning, escort, transport, medical evacuation, tanker, ferry, deep air support, close air support, close-in fire support, and armed reconnaissance. Both fixed wing and rotary aircraft can be represented. Aircraft launch and recovery can be affected by weather conditions or air base status. Aircraft availability for further missions is affected by aircraft turnaround time and maintenance factors. Air defense play includes surface-to-air weapons and vectoring of CAP aircraft to intercept an enemy track. Airborne radar or passive electronic support measures can be used to detect other air or surface objects. [Ref. 24]

#### *c. Ship-to-Shore Movement*

Amphibious landing plans and contingency plans can be prepared and rehearsed in the simulated environment. MTWS can be used to identify beaches for surface assaults; landing zones for airborne assaults; amphibious shipping from which pre-loaded landing craft are launched; transport areas; rendezvous points; and special operation force departures. The system represents the variety of operational options, including over-the horizon, underway launch, beaching, or causeway offloading. [Ref. 24]

#### *d. Fire Support*

The MTWS fire support capability includes ballistic weaponry such as artillery, mortars, multiple rocket launchers, ground-to-ground missiles, naval gunfire, and guided weapons such as surface and air launched cruise missiles. Fire missions can be scheduled, predefined for on-call initiation, or called for immediate fire. MTWS provides representation of control measures to include Coordinated Fire Lines, Fire Support Coordination Lines, Fire Support Areas, unit boundary lines, and Restricted Fire Areas among others. [Ref. 24] *e. Combat Service Support*

MTWS models consumption of ammunition, fuel, water, and rations during the simulation to model Combat Service Support (CSS) play. MTWS can be used to plan and coordinate resupply operations from beach supply areas or other supply points using ground, air, or water transportation units.

*f. Combat Engineering*

MTWS allows for the construction (instantaneously or over time) of structures, obstacles, barriers, minefields, roads, and bridges. Combat Engineering operations performed over time is based on availability and size of the unit and type of activity to be performed.

*g. Other Functions Modeled*

Other factors to include weather (temperature, visibility, cloud cover, rain, humidity, sea state, and wind), physiological factors (fatigue), psychological factors (suppression, causalities), and NBC are also modeled.

### 2. Technical Description

MTWS executes on a UNIX-based distributed architecture consisting of three to six simulation processors, a system control workstation, and several controller workstations. The simulation processors run the combat models. The system control workstation manages the exercise clock, external system interfaces, and data conversions between the simulation processors. [Ref. 24] (Note: As of 07 June 1999, an interface allowing MTWS to access, retrieve, and insert GCCS database information to MTWS wargaming scenarios will be added to the current version of MTWS.)

## I. NAVAL SIMULATION SYSTEM (NSS)

NSS is an object-oriented, Defense Modeling and Simulation Office (DMSO) High Level Architecture (HLA) compliant, Monte Carlo simulation system. NSS enables detailed analysis and understanding of battlefield events and their causes by tracking the outcome of simulated warfighting to individual elements in the "sensor-to-decision-maker-to-shooter" chain. [Ref. 25] NSS provides an automated ability to hypothesize and evaluate sets of alternate courses of action (COAs) to aid the Commander in COA development and selection. It can preview hypothesized scenarios before the conduct of the actual exercise and inject simulated platform, system, or commander level entities into real world C4I systems. NSS contains automated tools for conducting post exercise/experiment analyses, replay, and reconstruction; as well as a JFACC Tool, using the Targeting Management System (TMS), allowing for rapid reconstruction of Joint Integrated Prioritized Target Lists (JIPTLs) and Master Air Attack Plans (MAAPs). [Ref. 25]

### 1. Systems Description

NSS has been developed to provide in-depth analysis support for Naval and Joint Operations Planning and Decision Support, C4I Analyses and Assessments, Fleet Exercises and Experiments, and Fleet Training.

### *a. Naval and Joint Operations Planning and Decision Support*

NSS provides commanders across the spectrum of planning and decision making with a resource for developing and quantitatively evaluating alternative COAs. In addition it is used for execution decision support. [Ref. 25]

### *b. C4I Analyses/Assessments*

NSS provides a simulation tool to assess the value of Naval and Joint systems and concepts of operation (CONOPS) with warfare scenarios that integrate multiple warfare areas and which explicitly account for C4I interactions. These interactions include information collection, exploitation, and dissemination; tactical and targeting picture generation; decision-making, asset allocation, and target engagement. All these interactions are modeled within a user defined command and control structure. Analysis and assessment applications of NSS include the evaluation of new systems including their contribution to overall force capability, acquisition program Cost and Operation Effectiveness Analysis (COEA) support, and force structure analysis. [Ref. 25]

### *c. Fleet Exercises and Experiments*

NSS supports operational exercises and experiments by providing the capability to inject simulated systems, platforms, and command entities into a simulation federation that includes message exchange with real world C4I systems. NSS provides simulated sensor/platform reports, fused data, and data interpretation (e.g., Battle Damage Assessment (BDA)) to stimulate decision-maker action. [Ref. 25]

#### *d. Fleet Training*

NSS supports lecture/course augmentation for teaching operations and tactics. In this application it will provide statistical evaluation of warfighting outcomes under user-defined plans and tactics. NSS is also a tool for the generation of warfare scenarios and associated databases to support more general training applications. [Ref. 25]

### 2. Technical Description

NSS is a quantitative, object oriented (OO) force operations assessment tool. It is capable of simulating space, air, naval, and land forces engaged in single or multiple contingency operations at multiple levels of user selectable resolution. [Ref. 26] Object-orientation is the use of objects and classes in analysis, design, and programming. The use of objects distinguishes object-orientation from traditional structured methods (process-based: data and function are separate) or other techniques such as knowledge based systems or mathematical methods. Object oriented programs rely on messages sent between objects. An object actually contains code (sequences of computer instructions) and data (information which the instructions operate on). An object is defined via its class, which determines everything about an object. Objects are individual instances of a class. [Ref. 27]

In NSS, the key classes of object are *Commanders, Plans, Assets, Systems,* and *Force Interactions*. Each Commander has Plans and Assets. Each Asset has Systems. Force Interactions determine outcomes between classes of objects. Commanders are responsible for employing assigned forces. Commanders are subtyped into Group commander, Warfare Mission Area Commanders, and Asset Commanders. Plans contains the Commander's tasking to subordinate forces. Plans may give a general Commander's Intent or specific, pre-defined tactics. The Asset is the basic fighting unit employed in force operations. Systems provide a specific functional capability to Assets. Examples of Systems are weapons, communications, and sensors. Force Interactions determine the outcomes between object interactions. [Ref. 26]

## J. MICROSOFT NETMEETING

NetMeeting helps small and large organizations take full advantage of the global reach of the Internet or corporate Intranets for real-time communications and collaboration. While connected on the Internet or corporate Intranet, participants can communicate with audio and video, work together on virtually any 32-bit Windows-based application, exchange or mark-up graphics on an electronic whiteboard; transfer files, or use the text-based chat program.

### 1. System Description

The advent of NetMeeting 1.0 allowed people to use voice communication to interact and collaborate over the Internet. NetMeeting was the first to introduce multipoint data conferencing capabilities based on the International Telecommunications Union (ITU) T.120 standard. NetMeeting 2.0 was the next major release of Microsoft's multimedia communications client. Building on NetMeeting 1.0 audio and data conferencing capabilities, NetMeeting 2.0 integrated new features, as well as improved functionality and user interface enhancements.

First, NetMeeting utilizes Internet phone/H.323 standards-based audio support. Real-time, point-to-point audio conferencing over the Internet or corporate Intranet enables users to make voice calls to personnel and organizations around the world. NetMeeting audio conferencing offers half-duplex and full-duplex audio support for real-time conversations; automatic microphone sensitivity level setting to ensure that meeting participants hear each other clearly; and microphone muting, which lets users control the audio signal sent during a call. This audio conferencing supports network TCP/IP connections. [Ref. 28]

Second, NetMeeting utilizes H.323 standards-based video conferencing. With NetMeeting, a user can send and receive real-time visual images with another session participant using any video for Windows-compatible equipment. They can share ideas and information face-to-face, and use the camera to instantly view items, such as hardware or devices, that the user chooses to display in front of the lens. Combined with the audio and data capabilities of NetMeeting, a user can both see and hear the other session participants, as well as share information and applications. [Ref. 28]

Third, NetMeeting contains an Intelligent Audio/Video Stream Control tool. NetMeeting features intelligent control of the audio and video stream, which automatically balances the load for network bandwidth, CPU use, and memory use. This intelligent stream control ensures that audio, video, and data are prioritized properly, so that NetMeeting maintains high-quality audio while transmitting and receiving data and video during a call. Using NetMeeting custom settings, organizations can configure the stream control services to limit the bandwidth used for audio and video on a per-session basis. [Ref. 28]

Finally, the bulk of NetMeeting's features are packaged in Multipoint data conferencing. Two or more users can communicate and collaborate as a group in real time. Participants can share applications, exchange information through a shared clipboard, transfer files, collaborate on a shared whiteboard, and use a text-based chat feature. Also, support for the T.120 data conferencing standard enables interoperability with other T.120-based products and services. [Ref. 28]

The following features comprise multipoint data conferencing:

***a. Application sharing***

A user can share a program running on one computer with other participants in the session. Users can review the same data or information, and see the actions as the person sharing the application works on the program (for example, editing content or scrolling through information.) Users can share Windows-based applications transparently without special knowledge of the application's capabilities. The user sharing the application can choose to collaborate with other session participants, and they can take turns editing or controlling the application. Only the user sharing the program needs to have the given application installed on their workstation. [Ref. 29]

#### *b. Shared clipboard*

The shared clipboard enables a user to exchange its contents with other participants in a session using familiar cut, copy, and paste operations. For example, a participant can copy information from a local document and paste the contents into a shared application as part of group collaboration. [Ref. 29]

#### *c. File transfer*

With the file transfer capability, a user can send a file in the background to one or all of the session participants. When one user drags a file into the main window, the file is automatically sent to each person in the session, who can then accept or decline receipt. This file transfer capability is fully compliant with the T.127 standard. [Ref. 29]

#### *d. Whiteboard*

Multiple users can simultaneously collaborate using the whiteboard to review, create, and update graphic information. The whiteboard is object-oriented enabling participants to manipulate the contents by clicking and dragging with the mouse. In addition, they can use a remote pointer or highlighting tool to point out specific contents or sections of shared pages. [Ref. 29]

#### *e. Chat*

A user can type text messages to share common ideas or topics with other session participants, or record meeting notes and action items as part of a collaborative process. Also, participants in a session can use chat to communicate in the absence of audio support. A "whisper" feature lets a user have a separate, private conversation with another person during a group chat session. [Ref. 29]

### 2. Technical Description

Designed for corporate communication, NetMeeting 2.0 supports international communication standards for audio, video, and data conferencing. With NetMeeting 2.0, people can connect by modem, ISDN, or local area network using the TCP/IP protocol, and communicate and collaborate with users of NetMeeting 2.0 and other standards-based, compatible products.

NetMeeting is both a client and a platform. The NetMeeting client enables users to experience real-time, multipoint communication and collaboration program. The NetMeeting platform enables third-party vendors to integrate conferencing features into their own products and services. To support this dual purpose, Microsoft implemented NetMeeting capabilities using an open architecture of interworking components. Each component communicates with and passes data to and from the component layer above and below. This open architecture means that vendors can develop products and services that build on the NetMeeting platform and interoperate with NetMeeting client conferencing features. [Ref. 28]

At the core of the NetMeeting architecture is a series of data, audio, and video conferencing and directory service standards. These standards work together with transport, application, user interface, and conferencing components to form the NetMeeting architecture. At its lowest level, standards are responsible for translating, sending, and receiving NetMeeting information. The NetMeeting architecture includes protocols for modem and network TCP/IP connections. The modem protocol supports data-only conferencing connections and TCP/IP connections support NetMeeting audio and video.

The NetMeeting architecture is based on the following industry standards:

- The International Telecommunications Union (ITU) T.120 standard for data conferencing
- The ITU H.323 standard for audio and video conferencing
- The Internet Engineering Task Force (IETF) lightweight directory access protocol (LDAP) standard for directory services support.

These standards provide the framework for managing NetMeeting connections, data conferencing, audio and video capabilities, and directory server access. [Ref. 28]

This chapter introduced several C2 systems supporting the C2 process discussed in Chapter II. Brief system and technology descriptions were discussed to provide basic information on applications available in the STBL. These descriptions were not meant to be comprehensive user's guides. Each of these applications can be integrated to initiate and complete the C2 process introduced in Chapter II. Table 1 illustrates the integration of these chapters and is a quick-reference matrix to aid in the planning of activities utilizing the STBL. Chapter IV will step through a fictional scenario to illustrate the integration of the C2 process and its systems.

| | Operational Planning/DCP | Modeling and Simulation | Battlespace Management | Intelligence Analysis |
|---|---|---|---|---|
| COMPASS | X | | | |
| C2PC | | | X | |
| ELVIS II | X | | | |
| GALE-LITE | | | | X |
| GCCS | | | X | |
| GROUPSYSTEMS | X | | | |
| LAWS | | | X | |
| MTWS | | X | | |
| NSS | | X | | |
| NETMEETING | X | | | |

Table 1. STBL Quick Reference Matrix

# IV. EXAMPLE SCENARIO

This chapter uses the information from Chapters II and III to develop a scenario to illustrate the integration of the C2 Process and Systems that enable the IT-21 concept. The concept will be applied to a simulated military crisis employing the C2 Process and Systems described in the previous chapters. The scenario will progress through a crisis in a distant third-world country adapted from a story line developed for the Naval Research and Development (NRaD) video "Dominate the Battlespace." [Ref. 30] This scenario can be simulated in the STBL and other existing battle labs.

## A. INTRODUCTION

With the end of the Cold War and the emergence of the U.S. as the only remaining superpower in a world increasingly characterized by disorder, the U.S. has found itself involved in a number of "peace operations." These are complex, non-traditional missions to include disaster relief, United Nations peacekeeping and peace enforcement, non-combatant evacuations (NEO), crisis intervention, and combating terrorism. The future of these military missions is crisis avoidance or control. Dominance in the future will be dependent upon prevailing over space and time, transforming information into understanding, and moving knowledge rather than people. The ultimate force multiplier is envisioned as a totally integrated command and control approach that enables information to be obtained, protected, enhanced, shared and understood.

### 1. Scenario

The U.S. is engaged in a major theater conflict in the country of Kungsan located on the Asian continent. To complicate the global picture, in the country of Islandia (an island nation located near Indonesia) an organization of anti-government rebels, the Uneta Front, are attacking the American Consulate and endangering American citizens in residence. The Uneta Front anticipates that the U.S. military is over-extended and cannot respond successfully to the renewed conflict. The Commander-in-Chief, Pacific Command (CINCPAC) issues the order to Commander, Seventh Fleet (COMSEVENTHFLT) to break off from the Joint Task Force addressing Kungsan issues, take the USS Iwo Jima Amphibious Ready Group (ARG) and the USS Independence Carrier Battle Group (CVBG, one of three in the Kungsan arena) and conduct a non-permissive NEO operation to recover U.S. citizens and endangered foreign citizens from Islandia. COMSEVENTHFLT and the ARG respond and steam toward Islandia. Enroute to Islandia, COMSEVENTHFLT initiates their C2 cycle.

## B. C2 CYCLE

Upon receiving tasking from CINCPAC, COMSEVENTHFLT will assess the situation and begin to develop courses of action. After rehearsing the courses of action, COMSEVENTHFLT will select the most appropriate and implement the plan.

### 1. Situational Assessment

After issuing the order, CINCPAC initiates a video teleconferencing (VTC) session to further clarify the orders. In addition to CINCPAC, an NCA representative is present during the VTC session to outline the current status of the Islandia crisis. The NCA representative reports 375 to 400 hostages located primarily in the consulate at the Port of Bangara. CINCPAC authorizes Special Operations augmentation to be coordinated with CINC Special Operations Command (CINCSOC). In addition, CINCPAC reports that Typhoon Brenda is a possible threat to operations. Additional information is achieved in the COMSEVENTHFLT Command Center.

The initial situational assessment is completed and updated in the command center. GALE-LITE provides a fused-data intelligence product outlining the size of the insurgent forces at 30 to 40 personnel, the disposition of insurgent and government forces in and around Bangara, estimated locations of the consulate personnel and locations of items of interest in the immediate surrounding area (airport, beaches, communication sites, Surface to Air Missile sites, etc). The GCCS COP provides information on the status, availability, and location of U.S. resources in support of the NEO. Theater reconnaissance missions are requested through the GCCS GRIS application for additional theater intelligence. The COMSEVENTHFLT staff begins to plan and develop possible courses of action based on the available information.

### 2. Planning

From the information provided by CINCPAC, the NCA representative, and the intelligence analysis systems, the COMSEVENTHFLT staff begins course of action planning. The staff accesses a previously developed current theater operational plan in the GCCS JOPES database to assist in the planning cycle. Collaboration and coordination with resources outside of COMSEVENTHFLT is vital. The staff collaborates with CINC SOC at MacDill AFB, Florida to coordinate special forces participation in the NEO using ELVIS II to share map overlays and discuss possible insertion points. Maps of the Indonesian theater are pulled from the GCCS database and overlaid with the current COP. The CINC SOC staff marks possible Special Operations Force (SOF) insertion points on the map and "scribble" notes on the advantages and disadvantages of those points. In the same session, the staff collaborates with the JTF Marine Corps contingent (MARFOR) to discuss possible plans for the amphibious landing of the Marine Expeditionary Unit (MEU) to secure the surrounding area. Using different colors and pointers, the MEU annotates the suggested insertion points for the amphibious landing and comments on conflicts with possible SOF insertion points. The staff considers logistical issues ranging from the shortage of theater assets (due to continued operations in the Kungsan area) to providing essential resources to evacuees in a GroupSystems session involving the Kungsan JTF staff, CINCPAC staff, MARFOR, Federal Emergency Management Agency (FEMA), and Service Supply Commanders using Secret Internet Protocol Router Network (SIPRNET). In this virtual meeting room, for example, the JTF staff conducts "brainstorming" sessions on the possible needs of the evacuated personnel. The necessities are categorized and prioritized. The Service Supply Commanders remain in the session to discuss the even distribution of the workload to provide the required items. The COMSEVENTHFLT staff develops air support and evacuation plans with the CVBG air contingent and the Air Force's Air Mobility Command (AMC) utilizing COMPASS and its route preview and track management overlays. Planners will review possible routes and identify route and timing conflicts between support and tactical missions. Track management allows the session participants to identify route and timing conflicts with other missions registered on the GCCS COP. To supplement available information, the staff consults intelligence resources at the JTF National Intelligence Support Team (NIST) located at a stateside site to answer questions via NetMeeting. National Imaging and Mapping Agency resources are overlaid on the NetMeeting whiteboard and discussed via an adjoining chat session. Through this collaboration, the COMSEVENTHFLT staff assembles three viable courses of action. To test reliability and performance, the three plans are forwarded to the CINCPAC Crisis Action Planning Team for analysis.

### 3. Modeling and Simulation

The COMSEVENTHFLT staff forwards via classified electronic mail the three courses of action to the CINCPAC Crisis Action Planning Team in Hawaii. The three courses of action are then loaded partially or in their entirety into the Naval Simulation System (NSS). NSS provides an automated ability to assess deconfliction issues with other theater operations, produce casualty predictions, assess timelines, and arrive at a probability of success for each course of action. The modeling results are shared via COMPASS with the COMSEVENTHFLT staff for inclusion in their recommendation to COMSEVENTHFLT.

### 4. Implementation

COMSEVENTHFLT selects a primary course of action and a contingent course of action. The primary course of action is dependent upon clear weather for an AMC air-based evacuation. From the GCCS COP, COMSEVENTHFLT learns that Typhoon Brenda has changed directions and will prevent the timely arrival of the AMC aircraft. COMSEVENTHFLT initiates the amphibious-based contingency plan and monitors the execution of the plan as it unfolds. The SOF and the MEU are successfully inserted and are enroute to secure the port and evacuate the hostages. COMSEVENTHFLT continues to supervise the NEO via real-time video footage from Predator "pulled" from the Global Broadcast System. It becomes obvious that the SOF unit and hostages are under fire at the evacuation point and COMSEVENTHFLT receives a request for counter-fire. In response to this request for support, COMSEVENTHFLT inputs targeting information into the networked Land Attack Warfare System (LAWS). The LAWS counter-fire COP assesses and deconflicts the targeting information. The USS Chancellorsville receives the targeting information and initiates a round of counter-fire neutralizing the opposition. The NEO continues and results in the successful evacuation of all personnel.

# V. SUMMARY AND RECOMMENDATIONS

The scope of this thesis is limited primarily to C2 processes and systems resident in the STBL. However, the subject area of network centric and IT-21 concepts and applications extends to all levels of the military.

## A. SUMMARY

The rest of this section will summarize the contents of the thesis and provide recommendations as appropriate.

### 1. Chapter I

This chapter provided a brief overview of the concepts and visions prompting the update of the STBL. JV2010 introduces the emerging operational concepts of Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-Dimensional Protection enabled by Information Superiority. From JV2010 emerged the concept of network-centric warfare putting the emphasis of future warfighting on the seamless utilization of three Information Superiority grids: the information grid, sensor grid, and shooter grid. IT-21 is an umbrella Navy program accelerating the transition from current warfighting "platform-centric" standards to a PC-based tactical and support warfighting network. This chapter also discussed the rise of service battle labs to assist in researching and testing the new warfighting concept.

### 2. Chapter II

This chapter defined the C2 process and its application. Command and Control is segmented into three sub-definitions: the C2 function, C2 process, and C2 systems. The C2 process is further defined as the process of sensing the environment, processing the sensed information, comparing present state to the desired state, using decision aids in deciding upon the course of action to take and then acting upon that decision. The process in the STBL is reduced to four areas of concentration: Operational Planning, Modeling and Simulation, Battlespace Management, and Intelligence Analysis.

### 3. Chapter III

This chapter gave a brief overview of the C2 system applications in the STBL. The applications described include:

- Common Operational Modeling, Planning and Simulation Strategy (COMPASS)
- Command and Control Personal Computer (C2PC)
- Enhanced Linked Virtual Information System (ELVIS)
- Generic Area Limitation Environment – Lite (GALE-LITE)
- Global Command and Control System (GCCS)
- GroupSystems
- Land Attack Warfare System (LAWS)
- MAGTF Tactical Warfare Simulator (MTWS)
- Naval Simulation System (NSS)

- Microsoft NetMeeting

The chapter concludes with a quick-reference matrix illustrating the combination of the C2 process and the C2 applications. It is recommended that future upgrades of the IT-21 application builds are permanently included in the STBL strategic plan. It is necessary to upgrade as the latest versions of applications arrive to remain on the leading edge of researching new operational systems and concepts.

### 4. Chapter IV

This chapter produced a fictional example of how the C2 process functions in an operational environment and how the applications support this process at the JTF level. The scenario is a non-permissive non-combatant evacuation operation that depicted a JTF commander progressing through the four steps of the C2 process and employing the supporting C2 applications.

## B. CONCLUSION

Advancing technology continues to have a profound effect on the way the military is conducting future operations. The Systems Technology Battle Lab is one of several battle labs established to support the growing need to "change the way the military does business." The purpose of this thesis was to provide the average battle lab user with a common base to begin their exploration of the STBL, its resources, and the resources of other battle labs to realize the profound capabilities of Network Centric Warfare.

# APPENDIX: STBL INFRASTUCTURE

## A. LOCAL AREA NETWORK

The STBL has a 100-Mbps, fiber optic, Fast Ethernet LAN connected to an Asynchronous Transfer Mode (ATM) backbone. [Ref: 20]

## B. CONNECTIVITY

### 1. Secret Internet Protocol Router Network (SIPRNET)

The Defense Information System Network (DISN) has two separate Internet Protocol Router (IPR) Networks: the SIPRNET and the Unclassified but sensitive Internet Protocol Network (NIPRNET). The SIPRNET is a Wide Area Network that is separated both physically and logically from other networks. Each access circuit and backbone trunk is encrypted to ensure integrity of information. The SIPRNET uses several internetworking protocols to allow all types of traffic to traverse the network. These protocols include TCP/IP, File Transfer Protocol (FTP), Telnet, HTTP, and Simple Mail Transfer Protocol (SMTP). This SECRET router layer of the DISN is intended to support national defense C4I requirements, to include the use of STU-IIIs to make secure dial-up SIPRNET communication server connections. The SIPRNET supports many Joint C4I applications including GCCS and the Defense Message System (DMS). [Ref. 31]

### 2. Global Broadcast System (GBS)

GBS emulates commercial direct broadcast satellite technology to provide critical information to the warfighter. GBS is a space-based, high data rate communications link for the asymmetric flow of information from the U.S or rear echelon locations to deployed forces. GBS will "push" a high volume of intelligence, weather and other information to widely dispersed, low cost receiver terminals, similar to the set-top-box used with commercial systems. The system includes the capability for users to request or "pull" specific pieces of information. GBS is an extension of the DISN and a part of the overall DOD MILSATCOM architecture. It will interface with, and augment other major DOD information systems, such as GCCS and other theater information management systems. In addition, it will "push" real-time information feeds from systems like the Predator UAV to tactical operators. [Ref. 32]

### 3. Tactical Receive Equipment (TRE)

The Tactical Receive Equipment System receives, demodulates, decodes, decrypts, and processes information from Officer-in-Tactical Command Information Exchange Subsystem (OTCIXS) inputs on operational, support, and sensor information. It sends the decrypted signal to the Standard Tactical Receive Equipment (STRED) which in turn injects the information into GALE-LITE. STRED provides a user-friendly interface with TRE for filter building, receiver control, and high-resolution map display of OTCIXS data. [Ref. 33]

### 4. Integrated Services Digital Network (ISDN)

ISDN is a part of a series of modern networking technologies that provide wide area service. ISDN service integrates wide area data network service with voice telephone service. ISDN divides the user bandwidth into multiple channels over which computers can communicate. The Basic Rate Interface (BRI) provides an aggregate bandwidth of 144 Kbps divided into three channels. The interface provides a pair of "B" or bearer channels that operate at 64 Kbps, and one "D" or delta channel that operates at 16 Kbps. The D channel is used for the digital equivalent of dialing a telephone; a user sends requests across the D channel to establish or terminate connections to other users. The B channels carry data generated by a computer or digitized voice. The B channels can switch routinely between voice and data modes and can be combined to form a larger pipe. Conceptually, ISDN will replace the legacy analog telephone system. [Ref. 34]

## C. HARDWARE

The STBL's modular design is scaleable and flexible. It is reconfigurable to meet user requirements during experimentation and research. The STBL contains:

- 12 PCs running on the Windows NT (IT-21 compliant) operating system.
- eight SPARC Workstations running GCCS
- 11 Hewlett Packard 9000 Workstations used for MTWS experiments
- two whiteboards (softboards)
- one overhead projector

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